Petroleum Processing

Petroleum Refining • Petrochemical Manufacturing • Gas Liquids Recovery OCTOBER, 1956

ample of a significant new trend is
Oil's approach to marketing: one
np blending your choice of five grades

How will super gasolines affect the industry?

—p. 51

Also In This Issue:

NEW PROCESS for catalytic cracking feed preparation boosts yields and efficiency
—p. 55

BETTER COST CONTROL by using novel "instrument" charts
—p. 70

SAFETY HELPS YOU foot the bill for improved maintenance
—p. 78

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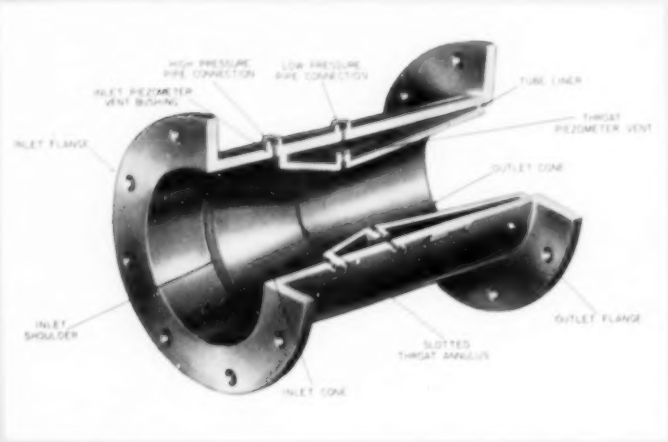
PRICE 35 CENTS

DON'T LOSE YOUR HEAD!



IT CAN PROVE COSTLY!!!

THE PROBLEM

Head loss can prove expensive. The natural gas industry finds this increasingly true as the booming market for this commodity makes the industry more "efficiency conscious". Modern conservation practices have become a must . . . and a definite trend toward replacing the conventional orifice plate with the Dall Flow Tube has started.

THE SOLUTION

The Dall Flow Tube operates with the lowest head loss obtainable with any known velocity-increasing differential producer. This flow measuring device is unsurpassed for differential pressure recovery . . . with consequent savings in pumping and transmission costs. These advantages apply over a full range of throat-to-line-diameter ratios. Besides providing a maximum in power savings, additional savings can be realized at initial installations. A single Dall Flow Tube can replace several parallel large orifice runs requiring longer approach sections of straight pipe.

Additional Features

★ *The discharge coefficient of the DFT is stable and constant over a wide flow range (for flows above a Reynolds number of 300,000). Complete range data are available on request.*

★ *"Enduring accuracy" is achieved since Dall Flow Tubes are self-scouring and of such rugged, durable construction that all critical dimensions and surfaces remain unchanged even after years of service. The size and weight of these units provide ease of installation.*

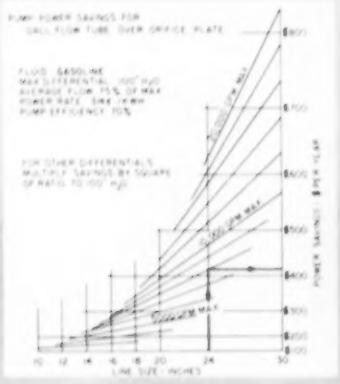
"THE BEST COSTS LESS"

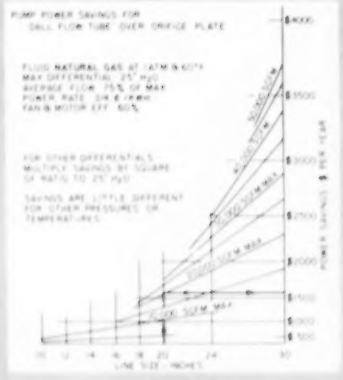
TECHNICAL DATA

PUMP POWER SAVINGS

Annual savings to users of Dall Flow Tubes may be approximated by referring to the charts below. Each is entered at the bottom at the appropriate line size and traced vertically to the intersection with the sloping flow line corresponding to the maximum capacity of the meter installation. The annual pumping power savings read along the vertical scale (right-hand side) opposite this intersection.

Although gasoline and natural gas are used in the examples, the order of yearly savings for other fluids is generally the same. Gases under other line conditions do not yield cost values markedly different from those shown.





Fabricated Dall Flow Tubes, which combine the advantages of the DFT profile and insert or flange mounting, are also available. The structure is a strong weldment of rolled plates and bar. All surfaces which are critical to the accurate prediction of flow characteristics are precisely machined to the Dall formula. This model offers design flexibility, low initial cost, and a wide choice of materials to suit application.

For complete details, write today for Bulletin 115-L1. Also ask for information on secondary instruments. Builders-Providence, Incorporated, 447 Harris Avenue, Providence 1, Rhode Island.

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They're stripping gasoline from gas with these "Oilwell" Direct-Connected Compressor Units

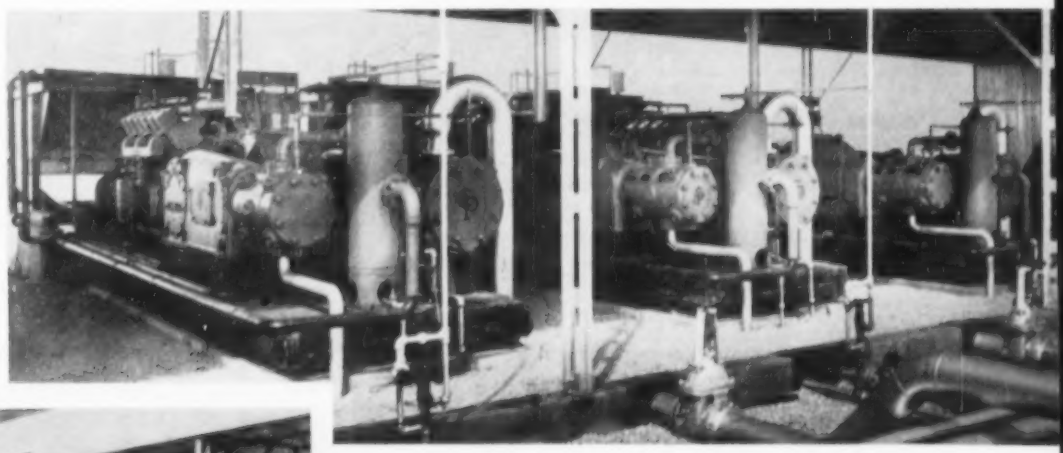
IN this modern gasoline and LPG plant near Norman, Oklahoma, some 3,550,000 cubic feet of gas per day is stripped of condensate and liquid petroleum products.

Three "Oilwell" DGE-250 two-stage compressor units take wet gas from separators at 5 psi and boost it to 445 psi for processing through the plant.

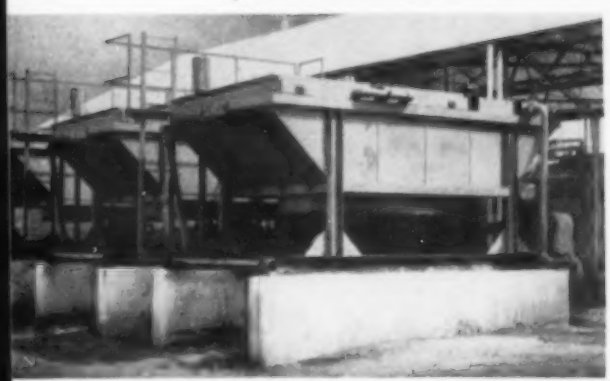
On each unit, the direct drive from prime mover, through right-angle gearing, to two parallel compressors, utilizes the input horsepower with maximum efficiency. V-belts and clutches are eliminated by this arrangement.

Units of this type are available in 125, 175, 200, 250 and 300-hp sizes. On all but the two larger sizes, up-draft radiators are mounted above the compressor gear box and supported directly from the skid base.

This bank of three direct-connected units are tied into a common header system, permitting flexibility of operation.



Heavy-duty, horizontal, up-draft radiators have divided cores for separately cooling engine and compressor. Circulating pumps and cooling fans are driven from the engine crankshaft by means of a torque tube and fluid coupling.



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Reader's Guide

What's New in Petroleum

The Time Table Has Changed

Not expected til 1960, new 100-plus octane gasolines are at the service station now (see this month's cover). How will they affect the industry? A thorough analysis of this significant new situation, by V. B. Guthrie. **p. 51**

I III 3 5

Feed Preparation Your Problem?

Do you want more and better charge stock for your catalytic cracking unit? Here's an as yet non-commercial process that might help. It uses a boron trifluoride-ethyl ether complex as a treating material for the cracker feed. **p. 55**

I 1 2 3

Boost Drawing Production

The last in a series of four articles by Robert Kern stresses the importance of co-ordinating overall design. Without this, factors covered in the previous articles cannot make a maximum contribution to more efficient drafting room practice. **p. 58**

I II III 2

Hydrogen Sulfide Is the Skunk

Even a small amount can shut down a fixed-bed catalytic reformer. Socony Mobil gives up-to-the-minute report on problems in Sovaformers, and the solutions, by E. B. Backensto, R. D. Drew, and J. N. Vlachos. **p. 64**

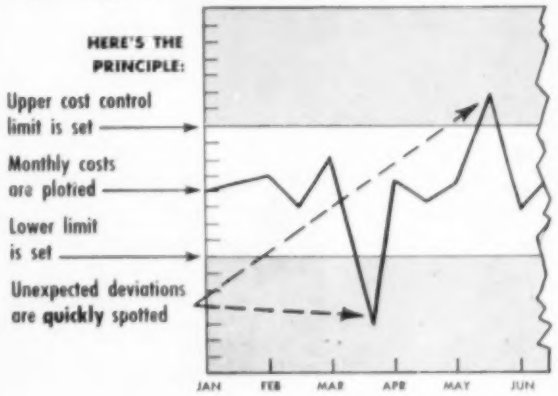
I 3 4

Pick the Right Pump for the Job

Here are three helpful charts to assist you in selecting the proper centrifugal pump – not too big nor too small. The charts correlate performance curves with curves of system conditions, by J. A. Cable. **p. 69**

I II III 3

Running cost control AT A GLANCE



Quick Visual Cost Check

As shown in drawing above, this is a fast way to spot troubles in your cost picture. Designed like an instrument strip chart, this graph and the system it is part of are detailed for you by John N. Watson, British American Oil Co. **p. 70**

I II III 3 4 5

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Processing for October, 1956

I II III 1 2 3 4 5

Safety Pays Its Way Well

. . . in maintenance too. But it takes plenty of planning and hard work. M&C Panelist J. B. Adams, of U. S. Oil & Refining Co., tells how. And in the M&C Problem Corner — the panelists reply to a query on "best way to get maintenance costs." **p.78**

I 4

New Circular Boiler

. . . for using carbon monoxide as part of its fuel has just completed a successful run of over six months at Sinclair's East Chicago refinery. Assistant combustion engineer N. E. Pennels discusses the design and tells how it worked **p. 82**

I 2 3 4

Technical Tips on Treating

. . . and associated problems. The fifth and last in our 1956 series of information-loaded articles based on tape-recordings of the popular question and answer session of the Western Petroleum Refiners' Assn. fall meeting. **p. 87**

I 3

Chemistry of Inhibitor Sweetening

More particularly, this article discusses the effects of variations in the olefins. R. H. Rosenwald, of Universal Oil Products, presents data on three olefins, verifying his explanation of the mechanism underlying the sweetening action. **p. 91**

I 1 3

I II III 1 2 3 4 5

Significant Ideas for Tomorrow

. . . as seen by the editors. Subjects this issue include: new Japanese ethylene process using Fluid catalytic technique, what temperatures the engineer of tomorrow will face, new ideas in lubes. Read this department regularly. **p. 15**

I II III 1 2 3 4 5

Are You Getting All You Want?

Your Readers' Service Card System is now designed to increase its efficiency for your convenience. Do you need extra copies of popular reprints of recent articles? How about extra copies of the "Clip-n-File" Data Sheets? **p. 143**

I II III 1 2 3 4 5

AND IN THE FUTURE

Watch the Issues Coming Up

. . . for a continuous stream of information and help on our job. Keep your eyes peeled for the postman. Don't miss out.

Articles coming in future issues will cover these subjects:

- Another big special report on a process of major significance today — the use of hydrogen in processing
- Tips on working with insulation for low temperature applications
- How to beat the problem of handling solid materials instead of liquids or gases
- Picking the right metal or alloy for corrosive service conditions

I II III 1 2 3 4 5

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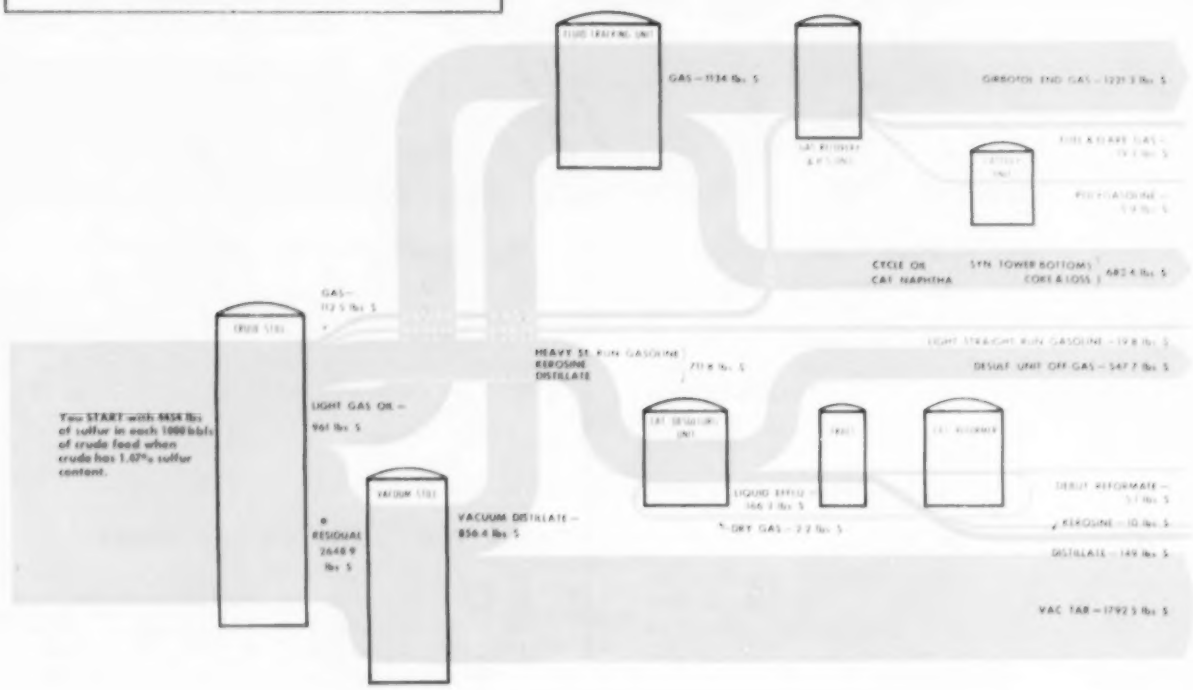
Continue "Readers' Guide" on p. 99

HOW TO USE IT:

Your new "Reader's Guide to What's New in PETROLEUM PROCESSING" will do two things for you. First, the key numbers with each article will tell you at a glance if it is within your scope of interest; Roman Numerals indicate industries; Arabic Numerals, fields of activity. Second, the longer descriptions will tell you what each article is about, and why it can be of help and interest to you. —The Editors

Where the Sulfur Goes



How to save up to 7¢ per barrel on lead

Ethyl Research studies show you can increase the octane number by decreasing the sulfur . . . and use less lead!

Getting the most from your lead is a complex business involving among other things, hydrocarbon blending and control of sulfur concentration in the fuel to be leaded. The Ethyl Corporation is constantly studying the interrelation of all the variables which affect lead utilization.

The antagonism of sulfur and tetraethyllead has long been known, but the refiner's problems today are 1) how much sulfur can justifiably be removed on the basis of savings in tetraethyllead and 2) what process can best be used to remove this sulfur. The advent of large volumes of high-pressure hydrogen at relatively low cost as a by-product of catalytic reforming processes has altered the entire economic picture of sulfur removal.

Actually the over-all justification of sulfur removal at one point or another in the refinery is composed of a number of complex factors including:

1. **Decreased product odor**
2. **Decreased refinery corrosion**
3. **Lessened refinery operating problems**
4. **Improved color and lessened gum formation**
5. **Improved tetraethyllead response**
6. **Sale of recovered sulfur**
7. **Avoidance of catalyst poisoning**
8. **Improvement in lube-oil life in the engine**

Of these various factors, perhaps the easiest to assign dollars-and-cents justification to (and certainly the one with most widespread application) is a saving in tetraethyllead.

Figure 1 shows the effect of the type of sulfur compound on Research octane number loss. This plot is based on U.S. pool gasoline which has a 79.2 Research octane number clear and a 92.0 Research octane number with 3 cc. of lead, and which contains 0.075 per cent total sulfur which may take the

(To obtain more data on advertised products see page 142)

form of the various compounds shown below.

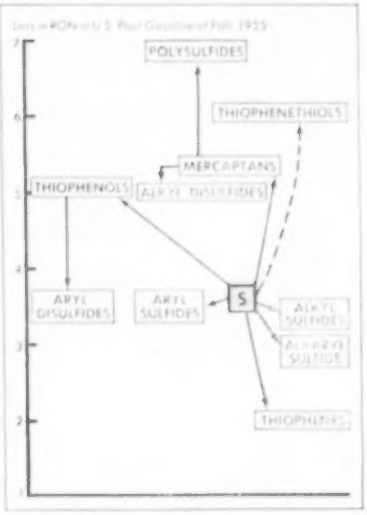


Fig. 1. *Effect of type of sulfur compound on RON loss*

Actually, a reasonable assumption would be that gasoline contains half monosulfide sulfur and half thiophenic sulfur. Complete removal of this sulfur, although economically attractive, is a practical impossibility. With the advent of hydrogen treating, however, there is no reason why 50% sulfur removal cannot become a reality. Figure 2 illustrates the TEL savings which are possible with 100%, 75% and 50% sulfur removal from U.S. pool gasoline of 91 RON with 2.38 ml. of TEL.

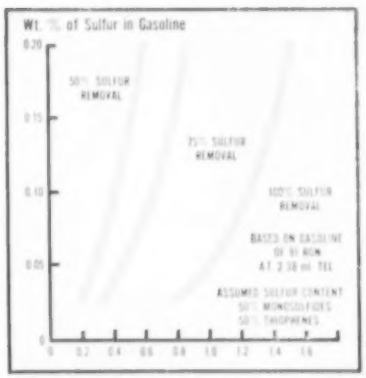

Wt. % of Sulfur in Gasoline
50% SULFUR REMOVAL
75% SULFUR REMOVAL
100% SULFUR REMOVAL
BASED ON GASOLINE OF 91 RON AT 2.38 ml. TEL
ASSUMED SULFUR CONTENT
50% MONOSULFIDES
50% THIOPHENES

Fig. 2. *TEL savings (ml. per gal.) with sulfur removal*

The average refiner, while he may be interested in the above data, still wants to know, "What's in it for me?" and Figure 3 answers this question. Here the possible savings in cents per barrel of gasoline are shown as a function of the weight per cent sulfur in the gasoline pool. This relationship is independent of the lead susceptibility of the particular stock and of the Research octane number level. Here, again, we are assuming half monosulfide sulfur and half thiophenic sulfur, and the economics of 50 and 75 per cent sulfur removal are shown for TEL levels of 1.5 and 3.0 ml/gallon.

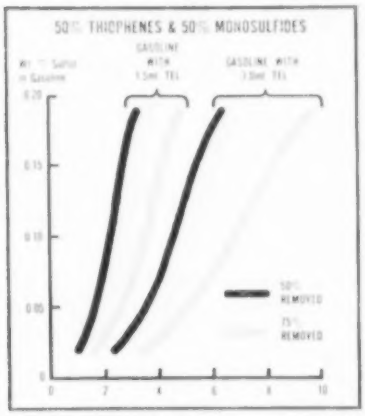


Fig. 3. *¢ per bbl. savings possible*

For example, it can readily be seen that a pool gasoline requiring 3 ml/gal of TEL and containing 0.10% sulfur could meet the same octane specifications with a saving in TEL cost of 7 cents per barrel if 75% of the sulfur were removed.

It is not unreasonable to assume that pool octane number could be raised one unit by desulfurization. Current octane-improvement costs, as shown by recent Ethyl studies, range as high as 16 cents per Research octane number per barrel. Therefore, 16 cents per barrel could be considered a justifiable expenditure for desulfurization on the basis of Research octane quality alone. Your justification will depend on the conditions specific to your refinery.

The optimum operation of your refinery to permit you to make the most of your lead could be the subject of a profitable discussion with your Ethyl refinery technologist. Your Ethyl Representative will be glad to arrange an appointment for you.

What Ethyl Research offers you

At today's high octane level, the advantages of getting more efficiency from your lead have taken on more and more importance. To complement the intensive effort which the industry is devoting to this problem, Ethyl Research is continuously studying how the hydrocarbon blending and sulfur removal factors can lower lead requirements.

We are constantly testing and probing all the variables which affect lead utilization in today's high-compression engines. The problem of sulfur removal and the sudden entrance of high-pressure hydrogen, as a by-product of catalytic reforming, into the economic picture is being watched very carefully at Ethyl Research. Write to Ethyl Corporation, Box 13, for a copy of "Sulfur in Gasoline—an Economic Appraisal"—another in the continuing series of reports from the Ethyl Corporation on fuel blending and other studies of vital interest to refiners today.

For further information, just call your Ethyl Representative. He'll be happy to arrange an appointment for you with one of our Technical Representatives.

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Publisher's Page

PP's Editors Are Broadened—But Not Fat

THERE are two ways for editors of a magazine like PETROLEUM PROCESSING to work. They can sit at their desks, write a lot of letters, and blue pencil meeting papers, press releases and contributed articles.

Or they can move around, attend technical meetings, visit plants, and talk with a lot of people.

The difference is this: The "stick-at-your-desk" editors merely parrot the industry. They report only what someone else wants reported. They have no sound basis for selecting material.

The "get-up-and-move-around" editors, in contrast, know their industry first-hand, its problems, its interests. They recommend publication of a paper because they heard it, and learned the audience reaction and questions. They usually ask outside authorities for articles, rather than wait for a contribution. And then they work with the author, helping him organize the article so that it will answer the questions they know are uppermost in their readers' minds.

The recent three-week trip Willis "Buzz" Bussard of our staff took to the West Coast is a good example of the sort of traveling our editors do. He had some editorial assignments, but he also kept moving around, getting acquainted with readers, as individuals. Among other things, he visited seven refineries in Washington and British Columbia, including the new 5000 b/d plant of Royalite at Kamloops. "Had to drive over 1000 miles to cover them," he reports, "and I sure wish I'd taken either a portable recorder or my secretary with me to make notes."

Buzz reported that "the continued growth of British Columbia's 'bubbling economy' is expected to resemble that of the last ten years in California. This province has an area greater than that of all three western states—and even greater than Texas. Yet the population is not much over a million and a half."

He also reports that the possibility of a third, higher grade gasoline in the Northwest seems remote. "There just isn't the need for it. Most driving is at higher altitudes than in the east; you don't do a lot of sustained, high speed driving in the mountains; high compression cars are not much in evidence; and the descendents of the early Scottish settlers will still look closely for real value."

Buzz picked up a lot of information and story ideas—and you'll be seeing the results for months to come. There's nothing like travel to broaden a person—particularly an editor.

William F. Bland

—Editor

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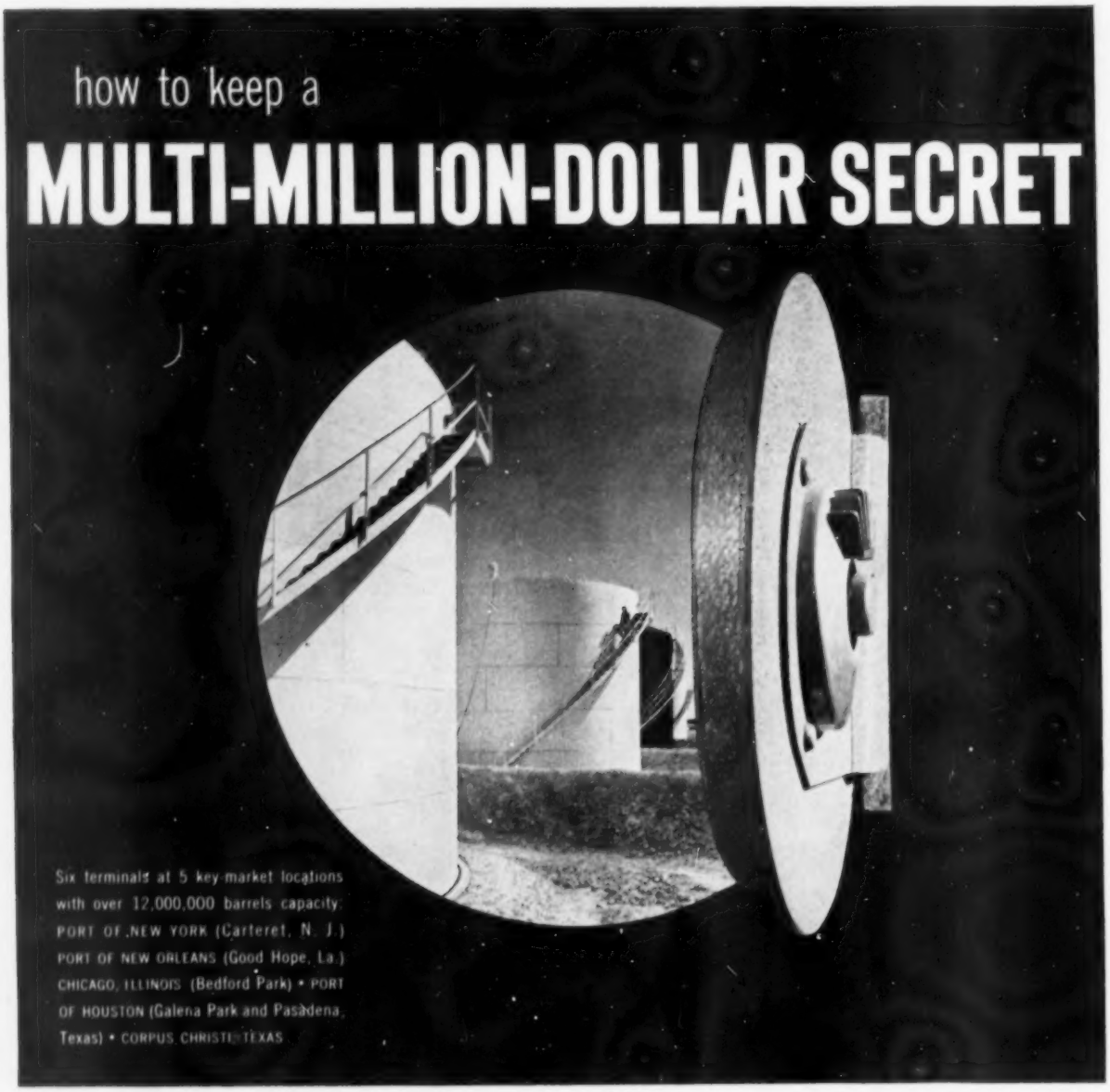
Petroleum Week
The industry-wide magazine—covering production, processing, transportation, marketing

how to keep a

MULTI-MILLION-DOLLAR SECRET



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What's Happening

in Refining

. . . **100-octane gasoline** is now well established. What will these super gasolines mean to the refining industry, and how will they be marketed? Already four years ahead of schedule for marketing 100-octane premium fuels (previously expected around 1960) are nine large oil companies either selling 100-octane fuel in addition to, or instead of, their established premium grade gasolines. For more details on the 100-octane race, see V. B. Guthrie's roundup, "100-Octane Hits the Stations," p. 51 of this issue.

. . . **Imperial Oil Ltd.** is in the midst of a growing catalytic reformer construction program. Latest announcement is for 5000 b/d Powerformer at its Ioco, B.C. refinery to be built by Canadian Bechtel Ltd. and expected onstream by Sept. 1957. Other Imperial Powerformers include a 9000 b/d unit at Montreal East being built, with similar units going up or onstream at Sarnia (13,500 b/d), Halifax (6300 b/d) and Edmonton (2200 b/d).

. . . **Union Oil Co. of Calif.** is reportedly building a Platformer-Unifiner unit at its Los Angeles, Calif., refinery with C. F. Braun & Co. already started on construction.

. . . **Standard Oil Co. (Calif.)** will begin building $75-million, 60,000 b/d refinery late next year near Everett, Wash.

. . . **Standard Oil Co. (Texas)** will have Fluor Corp. Ltd. design, engineer and construct a 27,000 b/d Model IV fluid catalytic cracker at El Paso, Tex. Completion of the $5-million-plus job is scheduled for Sept. 1957.

. . . **Frontier Oil Refining Co.** will start early construction of a 1370 b/d aromatics recovery unit at the Buffalo, N. Y., refinery. Scheduled onstream late 1957, the new unit will get charge stock from a new 7500 b/d catalytic reformer due onstream late this year.

. . . **Humble Oil & Refining Co.** will have Foster Wheeler design and build a 55,000 b/d Fluid catalytic cracking unit at the Baytown, Texas, refinery.

. . . **British American Oil Co.** has awarded a contract to Canadian Kellogg Co., Ltd. for two crude distillation units to add 40,000 b/d of crude capacity to the 21,500 b/d refinery at Clarkson, Ont. Cost is estimated at $5.5-million.

. . . **Gulf Oil Corp.** has placed a 22,500 b/d visbreaker onstream at its Philadelphia, Pa., refinery. The unit, Gulf's own design, is said to combine conventional thermal cracking of heavy residues with an improvement allowing it to process heavier crude fractions than previously practical.

. . . **The Texas Co.** is taking up options on property near Anacortes, Wash. for its new refinery, reported for 30,000 b/d capacity, to cost about $50-million.

. . . **Standard Oil Co. (Ind.)** will build a new waste water purification facility at its Casper, Wyo., refinery. Refinery Engineering Co. has the project contract, with completion due early 1957.

. . . **Oil refining capital expenditures** will climb to about $3,341-million in 1956 from $2.798-million in 1955 and $2.684-million in 1954, according to joint survey of Commerce Dept. and Securities and Exchange Commission.

. . . **Refining payrolls** in the U.S. have increased 52% in the last seven years (from $535.8-million to $816.8-million) while total payroll employes increased only 5.1% (from 145,800 to 153,200), during which time the total number of refineries dropped from 437 to 409—according to recent Census Bureau report.

. . . **Texas Asphalt and Refining Co.** will put its new $4-million, 5000 b/d asphalt plant, located on the Houston (Texas) Ship Channel, onstream Sept. 20.

. . . **Tennessee Gas Transmission Co.** has placed a 5000 b/d Platformer onstream at its Chalmette, La., refinery (formerly the Bay Petroleum Corp.). Feedstock will be a combination of naphtha from Louisiana crude and distillate from Louisiana Gulf Coast crudes.

. . . **Ingram Products Co.** has put a 3000 b/d Platformer onstream as the completion of a major phase of a multi-million dollar expansion program. Feed to the Platformer is a mixture of Louisiana natural gasoline, and naphtha from Louisiana crude.

. . . **American Oil Co.'s** 21,000 b/d hydrodesulfurization unit (reported in PETROLEUM PROCESSING, Sept., 1956, p. 9), to be built at Texas City along with a 21,000 b/d Ultraformer, is a Standard Oil Co. (Ind.) licensed process, not a Sovafiner as previously reported.

in Gas Liquids Recovery

. . . **Texas Natural Gasoline Corp.** plans a gasoline plant north of Baker, Mont. It will strip propane, butane and natural gasoline, sending the residual gas for sale to Montana-Dakota Utilities Co. This is the second plant of its type in Montana. The other is at Cut Bank.

. . . **Production of natural gas** liquids in the U.S. increased 13% from June 1955 to June 1956 (up to 31.9-million gal/day) and production of liquefied gases

at refineries increased 9% to reach 5.6-million gal/day —according to recent Bureau of Mines report.

in Petrochemicals

. . . **New low-pressure polyethylene process** has been unveiled by Metal Hydrides Inc. The process uses *in situ* catalyst of sodium-hydride-reduced titanium halides, with or without aluminum chloride (depending upon reaction pressure used).

. . . **Ethyl-Dow Chemical Co.** will increase ethylene dibromide production capacity 20% at its Freeport, Texas plant. Completion is due fall-1957.

. . . **United Carbon Co.** will add four reactor production units to its Louisa, La., carbon-black plant for a cost of $750,000.

. . . **Polymer Corp.** will build a $15-million butadiene plant in Western Canada, probably near Red Deer, Alta.

. . . **Petroleum Chemicals, Inc.** will take over operation of the former government butadiene plant at Lake Charles, La., from Cities Service Refining Corp. Petroleum Chemicals is jointly owned by Cities Service and Continental Oil Co.

. . . **The Teaxs Co.** will build a 200 t/d nitric acid plant as part of the ammonia plant now under construction at their Lockport, Ill., refinery. The nitric acid plant will use the CSC Stengel reactor, and will be designed and built by Chemical and Industrial Corp., with onstream due during 1957.

. . . **New styrene plant plans** for Orange, Texas, have reportedly been canceled by Goodrich-Gulf and Firestone because of long-term contract price cuts by present producers.

. . . **DuPont Co.** has cancelled plants to add a sodium and chlorinated solvents unit at its Antioch, Calif., plant. This has no effect on the tetraethyl lead and Freon plans at Antioch.

in Transition

. . . **Resistance to sale of** Universal Oil Products Co. stock by the American Chemical Society has come from three more independent oil refiners, joining four previous dissenters and the Independent Refiners Assn. of America. Opposition feels that sale would deny small refiners the benefits of UOP research and development now available.

. . . **Northwest Production Co.,** wholly owned subsidiary of Pacific Northwest Pipeline Corp., plans to buy Western States Refining Co., Salt Lake City, Utah. Western has a 3500 b/d refinery at North Salt Lake and a 1200 b/d refinery at Farmington, N.M.

. . . **Britalta Petroleum, Ltd.** of Calgary, Alta. may soon acquire Wilshire Oil Co. of Texas if the stockholders agree with directors of both firms.

. . . **Jefferson Lake Sulphur Co.** plans to merge Merichem Co. (94% Jefferson owned) into its operations as Jefferson's petrochemical division.

. . . **Gulf Oil Corp.** has bought the second $60-million worth of Union Oil Co. of Calif. debentures, making a total of $120-million held by Gulf.

. . . **New name for Escambia Bay Chemical Corp.** will be Escambia Chemical Corp., with offices headquartered in New York City.

. . . **Standard Oil Co. (Ind.)** has consolidated Hidalgo Chemical Co., Indoil Chemical Co. and Pan American Chemicals Corp. (all Indiana Standard subsidiaries) into a chemical combine named Amoco Chemicals Corp.

. . . **The Texas Co.** has completed purchase of the British-owned Trinidad Oil Co. for $176-million with formal approval by Trinidad's stockholders in early Sept. Trinidad Oil has integrated interests in Trinidad and Canada, with marketing and refining interests in Britain.

. . . **Pacific Petroleums, Ltd.** has bought rights and options for up to 50% of the outstanding common stock of X-L, a subsidiary of Excelsior Refineries, Ltd. X-L, a subsidiary of Excelsior Refineries, operates a 3000 b/d refinery at Dawson Creek, B.C.

in Foreign Operations

. . . **Britain and Europe:**

Shell Petroleum Co. has put into operation a modern grease plant at Wein-Simmering, Austria. In combination with the refinery at Florisdorf, Shell Austria A.G. will supply almost 75% of the grease needed by it for home markets.

Czechoslovakia has resumed work on the Bratislava refinery in Slovakia Province stopped for a year because of other needs in the national economics plan. The capacity has not yet been announced.

Albania's Cerrik refinery has been finally finished, though originally scheduled for 1954. It has a capacity of about 2700 b/d crude.

The Van Sickle Co. will build a 500-700 b/d refinery in the Neusiedel/Zaya field in Austria.

. . . **Latin America**

A joint refinery by five Central American countries

Danger... Corrosion at work!

ABOUT THIS PHOTOGRAPH—In capturing this closeup of corroded "coupons" and a distance shot of a refinery on the same negative, well-known photographer Bernard Hoffman achieved amazing depth of focus. Using revolutionary techniques which he has pioneered, Mr. Hoffman is able to achieve over-all sharpness of near and far objects; long the goal of photographers.

Internal refinery corrosion, as measured by these badly corroded coupons, is becoming a thing of the past where Polyrad inhibitor is used. Because Polyrad is a filming amine, it forms a molecular film that protects metal from attack. And Polyrad's detergent action aids in keeping the metal surfaces clean, thereby maintaining heat transfer and operation at unit capacity.

Polyrad is available from stocks maintained throughout the country. We'll be glad to tell you how to protect your refinery with Polyrad.

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Pine Chemicals Division, Naval Stores Department **HERCULES POWDER COMPANY** *984 King St., Wilmington 99, Del.*

is being considered. Nations are Nicaragua, El Salvador, Honduras, Costa Rica, and Guatemala, none of which has a refinery now.

Venezuela's Petrochemical Institute has announced that its contracts with Blaw-Knox Co. have been terminated. The Venezuelan government will take direct charge of design in the $150-million project.

. . . the East

Daikyo Oil Co., Ltd. will add a 3000 b/d Houdriformer (the first in the Far East) at its Yokkaichi, Japan, refinery. The unit will process Arabian and other Middle East crudes.

A new process to make ethylene and propylene directly from petroleum has been developed by Dr. Shigeru Tsutsumi, of Osaka University, Japan (see p. 15, this issue, "New Ethylene Process Nearing Startup in Japan Promises Much"). Yields of 30% ethylene and 15% propylene from crudes and heavy oils (with end points up to 660°F) are claimed for the moving-bed, fluid catalytic process. Kurashiki Rayon Co., near Osaka, is scheduled to startup a plant based on this process later this month, and the Yahata Iron Works of Kyushu, Japan, has another plant under construction.

Travancore Ltd. will spend $4.1-million to increase ammonia capacity to 80 t/d within the next two years at the Alwaye, India, plant. Also planned is capacity increase for ammonium sulfate production and initial manufacture of ammonium phosphate.

Idemitsu Kosan Co., Ltd. will build a 30,000 b/d refinery at Tokuyama, Japan, 800 miles southwest of Tokyo. Cost will be about $25-million, with onstream scheduled for 1957. Units in the refinery will include UOP fluid catalytic cracking, Platforming, Unifining and Unisol.

Syrian government has turned down Soviet Russian offer to build a refinery in Syria as "incompatible with the terms of the tender . . . submitting a simple catalogue with photographs . . . usually distributed free by firms for publicity purposes."

in Markets and Prices

. . . Rumblings of shaded gasoline prices persisted throughout the Midwest and Mid-Continent, and finally gave way to reductions in quotations in the Chicago District last month. Noticeably absent, however, were distress offerings at the Gulf despite large inventories.

Cutbacks in crude runs—reflecting growing concern over top-heavy gasoline stocks—were gaining momentum. By mid-September, five major refiners had announced they were scaling down operations.

. . . First business in the U.S. inspired by the Suez crisis showed up last month. French buyer took three cargoes of crude—two of West Texas oil, and one of Van (Tex.) crude—for Fall lifting. Inquiries totaling large volume of Texas crude also were in the market.

. . . Prices for volatile products pointed upward. LP-gas prices rose 0.5¢ in the Southwest, and a similar increase was chalked up for Grade 26-70 natural gasoline, on both Group 3 and Breckenridge basis.

. . . Marketers expressed little concern over the high level of distillate fuel stocks. Demand for heating oils showed the first signs of life as cold weather hit the upper central states, and "off-price" product was gradually disappearing from the Mid-Continent. Trading was at a standstill at the Gulf except for some winter cargo arrangements with eastern buyers. Discounts on spot material were still being offered in the East.

Heavy fuel recovered 5¢ of the 10¢/bbl reduction made in 1% maximum sulfur price at the Gulf when supplies backed up during the steel strike. Resulting new low quotation is $2.20/bbl.

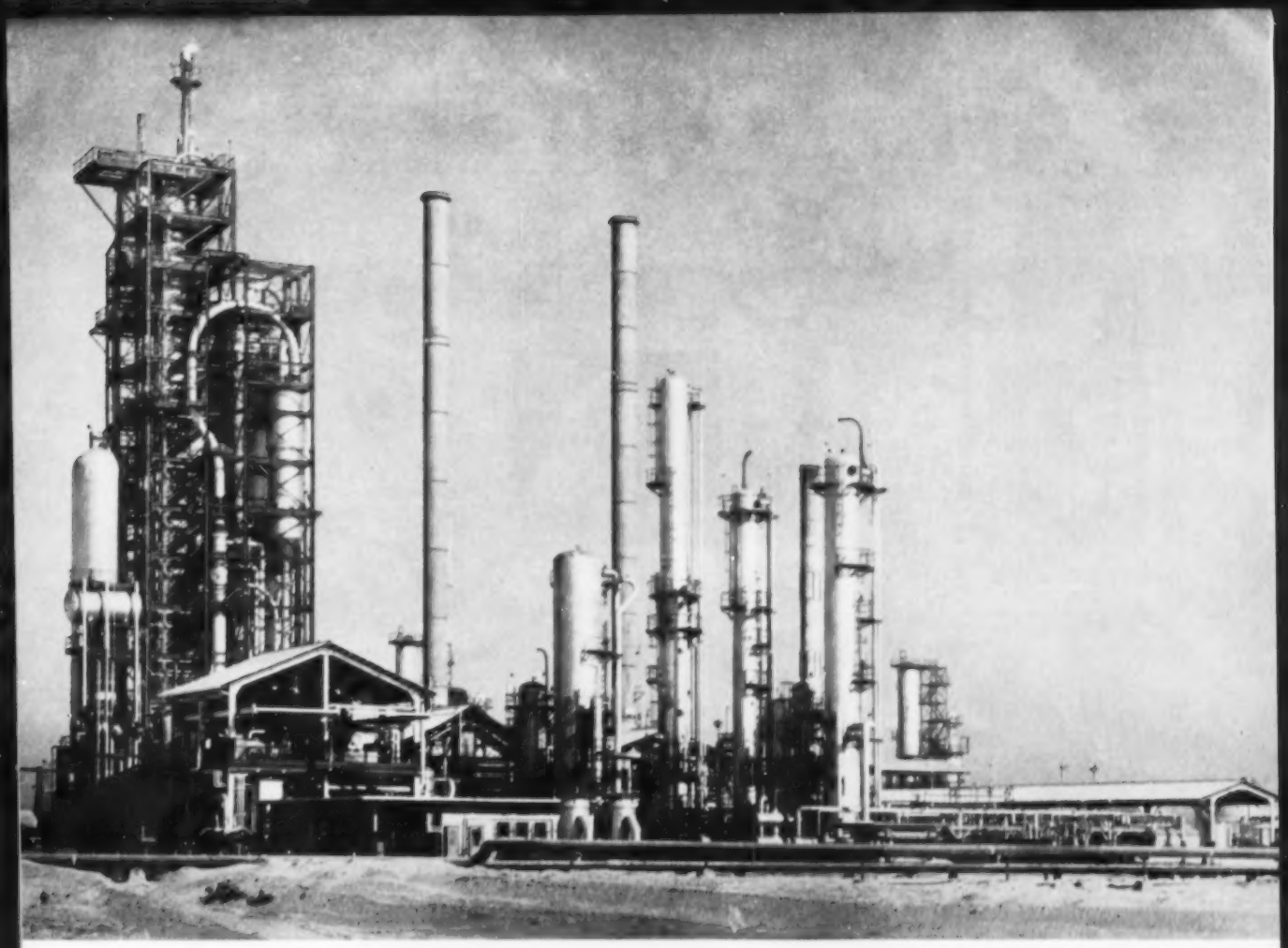
. . . Other price developments included a 1¢/gal hike in South Texas lubricating oils, and 0.5¢/lb increase in domestic crude scale wax prices in the East.

Looking Ahead

. . . Fuel-injection for cars is here—almost. Chevrolet is said to be making the first break in the passenger car field. The system—which eliminates the carburetor—reportedly will be optional on Chevrolet's 1957 higher-horsepower engines, and its Corvette sports car. One of the Big Three car makers may also have optional fuel injection on one of its 1957 luxury models.

. . . New jet fuels for military aircraft and rockets have been requested of an oil industry already having difficulty making JP-5 for Navy carrier-based planes. B. F. Wilkes, of Aeronautics Div. Directorate of the Air Force's Research and Development told the National Petroleum Assn. that future needs would require as many grades of jet fuel as there are now grades of gasoline. Wilkes said the military needs would call for fuels with more BTU's per gallon, and would run to heavier hydrocarbons and narrower boiling ranges.

. . . Sinclair Research Laboratories, Harvey, Ill., will study effects of atomic radiation on petroleum processes and products, using U-235 in spent fuel elements from the Atomic Energy Commission's test reactor at Idaho Falls, Idaho.



Lummus, Aramco teamwork supplies more quality gasoline from Saudi Arabia

In August at Ras Tanura, Saudi Arabia, a 12,500 B/D Fluid Hydroformer is undergoing its first turnaround since it came on stream in October, 1955. For the past 10 months this unit has supplied 92.5 F-1 clear octane blending stock to European and Middle East markets, where the need for quality gasoline is growing rapidly.

The Hydroformer was designed and engineered by Lummus for The Arabian American Oil Company under license from Esso Research and Engineering Co. The process, though more complex than any other in the Ras Tanura Refinery, was designed for ease of operation to fit in with the Company's policy of training and upgrading Saudi Arab nationals to the fullest extent.

Close liaison among the three groups during all phases of design and construction has paid off. Startup was smooth, with all facilities operating at full design rate soon after feed was introduced. And the plant has been operating successfully ever since, at and above the design rate. In all cases, hydroformates of premium quality have been obtained from the high paraffin – low naphthene stocks characteristic of Arabian crudes.

Test runs at feed rates of 12,500 – 16,300 B/D have yielded products of 94.8 – 87.4 F-1 clear octane. There has been no difficulty in making the 92.5 octane design product at rates up to about 13,500 B/D. These tests indicate that hydroformates close to 95 F-1 clear can be produced in good yields, and should higher quality be needed, more severe hydroforming conditions appear to be feasible.

Aramco's new Hydroformer is one of over 700 major Lummus installations throughout the world. The excellent operating record of this new unit, and of Lummus plants in general, proves the case for coordinated direction of a project from idea to startup. Lummus teamwork can pay off on your next project.

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N. Y. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Indiana. *Engineering Development Center:* Newark, New Jersey.

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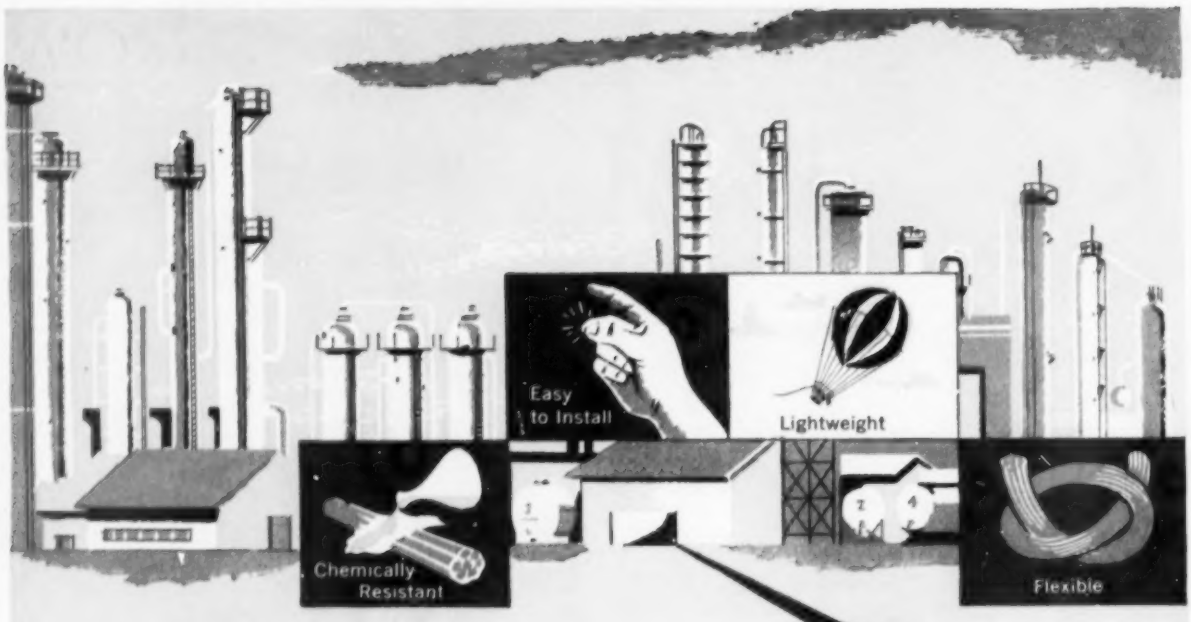

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(To obtain more data on advertised products see page 142)

New Process for Coating Steel With Plastics May Help Vinyls

HUGE though today's plastics industry may be, there are still some areas of potentially high market value demand that haven't even been scratched.

One such field is materials of construction for large volume buyers—the builders of homes, offices, and automobile bodies.

United States Steel Corp. is betting quite a few bucks on a brand new approach—a sheet of steel coated with vinyl plastic. The idea itself is not new. However, U. S. Steel has now succeeded in designing a process that will do it.

The finished plastic-coated steel has a tough, corrosion and abrasion resistant surface with the appearance of leather. It can be made in a wide variety of colors.

Full-scale commercial production is unlikely until a market of about 100,000 t/yr can be assured.

Applications visualized include panels for homes and offices, interior trim for automobiles and railroad passenger cars, radio and TV cabinets, and home appliances.

Final success depends of course on good acceptance. But, any progress in the vinyl plastics field will be watched with great interest by petrochemicals men concerned with growth in the sources for the vinyls, such as petroleum-derived acetylene. —W.C.U.

Will Tomorrow's Lube Be a Solid Material and a Plastic Fiber?

PRODUCING lubricating oils and greases until recently has had little glamour. Processes were "old hat", techniques were standard, and there was no "octane race" to generate competitive enthusiasm. But the recent applications of "dragon fur" (Teflon fiber) and a unique solid additive (MoS_2) to the field of automotive application may justify another look at tomorrow's lubrication picture.

For several years, molybdenum sulfide has been used for special problems, where a dry lubricant similar to graphite was required. Because of its unusual physical structure—a layer of molybdenum atoms sandwiched between two layers of sulfur—it acts as an efficient sliding surface. In the past MoS_2 was applied as a dry powder, or sprayed or dipped film. But now it has been successfully demonstrated that MoS_2 will deposit as a film from an oil slurry. This has a double advantage, not only as a method of application but as a supplement to conventional oil lubrication.

Because MoS_2 is chemically inert and thermally stable at temperatures higher than for normal hydrocarbon lubricants, it can supplement their use. As the oil or film of grease is removed by chemical or physical conditions, the deposited film of molydenum disulfide will act as a safety lubricant until the normal grease or oil is again applied.

Recent experimental work in the Research Labs of Climax Molybdenum Co. has confirmed that a film of this solid lubricant will deposit a protective film from a slurry of oil. Further work is under way now to perfect formulations and mixtures for its new applications.

The possibilities of using Teflon plastic, however, for bearing lubrication are different; its use may supplant conventional lubricants.

Although bearings of plastic material (nylon, for instance) are not new, the application of woven Teflon plastic is a new departure. Development at present is concentrated on its use in automobile suspension joints, which will completely eliminate the need for lubricating grease.

Using Teflon (tetrafluoroethylene) fiber in a ball-and-socket joint is achieved by double weaving it with a backing of nylon or cotton. This fabric is then laminated with cotton-reinforced phenolic resin and formed into a cup that lines the socket. The only use of grease is to prevent corrosion of the metal stud. A perfect spherical contact between the ball stud and the preformed bearing is assured by molding the bearing in place, after the joint is assembled. Then the joint is sealed. Already, preliminary tests have indicated that these bearings will last the lifetime of the car without any lubrication.

These interesting new materials, naturally, will not change the production schedules of many lubrication plants today. They are aimed primarily at special problems of lubrication, such as hard-to-reach areas, operation of frictional parts in extreme temperatures and in corrosive chemical conditions. But as applications of these materials are developed they may replace many conventional uses and thus affect tomorrow's production of lubricants. —W.A.B.

New Ethylene Process Nearing Startup in Japan Promises Much

THE WORLD'S petrochemical processors will be watching closely a new Japanese plant scheduled for startup later this month.

The plant belongs to the Kurashiki Rayon Co. near Osaka, and the reason for the widespread

interest is this: Kurashiki will be using a new Fluid catalytic technique for the production of ethylene and propylene from petroleum.

The process is vapor phase under reduced pressure (about 200 mm. Hg), operating on various feed stocks—heavy and light oils, kerosene, crude oil, or residual fuel oil. The composition of the catalyst has not been disclosed, but four patents have been applied for in Japan, the United States, and West Germany, and information should be available soon.

Yields of ethylene and propylene (plus residual oil) are reported to be slightly over 50 wt/% on once-through operation. With so-called "secondary cracking," yield of ethylene alone is 65-70 wt/%. Other products are methane, hydrogen, and aromatics.

Carbon deposition on catalyst is said to be very low because of the reduced pressure operation. Catalytic cracking rate is said to be about twice as high as that of any existing catalysts. Regeneration is required only about once a month.

Heart of the process is the cracking furnace, which was designed by Dr. Shigeru Tsutsumi, a professor in the Applied Science Laboratory of Osaka University. He has been researching since 1952 for new methods for deriving ethylene and propylene from petroleum.

In addition to the Kurashiki plant soon scheduled for operation, which will make acetylene, there is another plant being built to use the new Tsutsumi process. Yahata Iron Works of Kyushu has a plant under construction to produce ethyl benzene, cumene, and styrene.

No further information has as yet been made available. But it's a pretty good bet that the costs involved in the new process (including licensing royalties) have sold Japanese petrochemical enterprise into something attractive. Holders of existing American ethylene process licenses will be watching that Osaka plant with particular interest. (For further news on another recently developed process from the Orient, see p. 55 in this issue).—W.C.U.

New Man on the Research Team: The Literature Scientist

WILL petroleum companies find a place for this man in their research? Drug companies may be setting a new style by using the literature scientist as an integral part of the research team (**Chemical Week** Sept. 8, 1956, p. 80).

Properly used, he can save 25% of the laboratory men's time by doing their library work. Liaison among team members and with outside scientists is another of his functions. And, because he works in the mainstream of ideas, he is expected to be the team's chief idea-man.

He needs the broadest scientific background and training possible and should hold an advanced degree, preferably a doctorate. Laboratory experience, training in literature work, and a flair for writing are also required. Temperamentally, he must be able to follow the broad lines of the project without neglecting details.

Needless to say, the properly qualified literature scientist is a hard man to find. Time will tell whether finding him can bring a "payout" in efficiency to team research. —S.D.B.

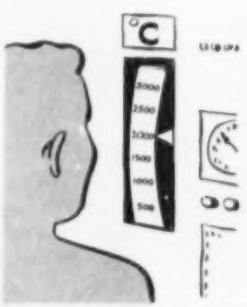
New Temperatures Mean New Thinking By Tomorrow's Engineers

WELL, "tomorrow" may mean the day after, but process designers, equipment designers, and engineers will soon be required to adjust their thinking to the ultra-high temperature phenomena they are likely to face in the foreseeable future.

At a recent three-day symposium on high temperature research at the University of Calif., Berkeley, 640 men gathered to discuss the problems of producing, containing, and using high temperatures. High temperatures, in their language, range up to 250,000° C.

An Atomic Energy Commission man stated that we will obtain nuclear source temperatures of 2000° C within the next five years under static conditions. This will occur in what might be termed reactor experiments of advanced design, and the first reactors will operate at around 1400° C.

Nuclear heat will undoubtedly be sought to hurry commercial application of some endothermic reactions such as acetylene from natural gas, and synthesis of hydrocyanic acid from methane and ammonia.



First goal of the researchers, however, is to find means and materials to contain temperatures of 2000° C and up—far higher temperatures than are found inside a blast furnace. Best bets at present are improved ceramics, although new metals and alloys aren't ruled out yet.

Whenever this tomorrow comes, designers and engineers must be prepared to accept radical physical changes in common elements. They must be equipped technically and temperamentally to cope with these new concepts in temperatures and materials. —R.E.C.

Letters

Drawing Efficiency

TO THE EDITOR: Recently, a survey by the alumni of Carnegie Institute of Technology in Pittsburgh showed that 83% of their science and engineering graduates have deserted their field. I believe that your discussion on how to "Increase Your Drafting Production" [by Robert Kern, July, pp. 78-82] typifies the mechanical approach to design work that has driven many engineers from the field and makes new graduates reluctant to enter it.

Let's look at the magnitude of the "savings" held out in your article. If we assume that the designer's time is worth $5 per hour, design costs for the pipe detail shown are:

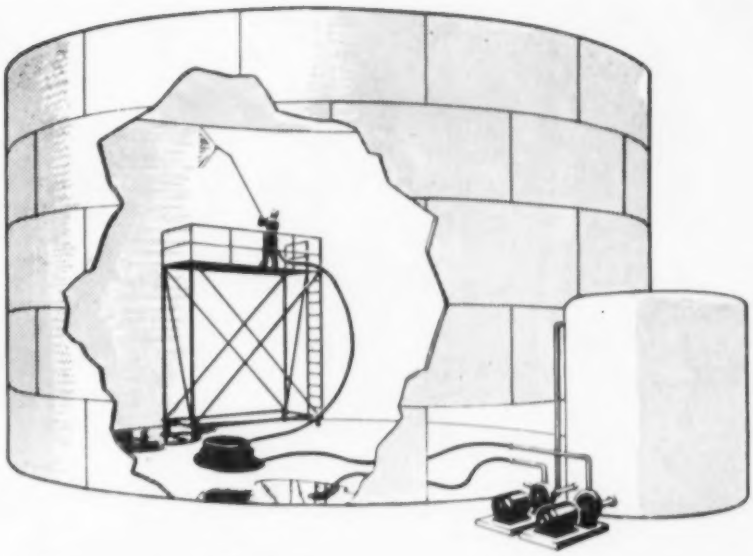
Type of Drawing	Time, min.	Cost, $	Saving, $
2-line conventional	125	10.42	——
Single-line isometric	72	6.00	4.42
Free-hand isometric	31	2.59	7.83

So, for a gain of less than $10, we have gone from a precise double-line drawing that shows up all possible interferences to a free-hand isometric sketch that is useless in this respect. A couple of field welds and cuts to correct an interference could easily cost ten times the alleged saving.

Is this saving worthwhile from the broader viewpoint of the job itself? A single weld in the 6-in. pipe of the detail costs several times $10. One 6-in. valve runs 5 to 15 times $10. The entire detail must cost 100 times the $10 saving. The procedure is somewhat reminiscent of the housewife who tries to economize on a holiday roast by skimping the cooking gas.

Of course, a drawing room should be conducted with maximum efficiency and economy. But it is dangerous to apply production stylecost-accounting methods to design work. A final design usually requires several discarded preliminary trials. Were the preliminary designs wasted? Is it true economy to so pressure the designer that he accepts a preliminary design that may ultimately cost thousands of dollars more than his final one? Can a designer's output be clocked like that of an assembly-line worker?

Some of your article's suggestions have real merit. But we know that a badly-timed effort to correct a golfer's bad habits may destroy his game. Similarly, a narrow approach to design



How a refinery cut storage tank cleaning costs by MORE than 75%

PROBLEM: Find a low cost method of cleaning an 80,000 gallon petroleum storage tank. Previous manual cleaning method was slow, wasteful, making costs extremely high.

SOLUTION: Utilizing standard equipment such as solution tank, pump, hose, piping and scaffolding (constructed from scrap) they set up a spray method using recommended Oakite solvent detergents. Entire installation constructed from working drawing supplied by Oakite Technical Service Representative.

RESULTS: By eliminating scrubbing, brushing and other manual cleaning methods, entire inside surface of storage tank was cleaned in only 12 hours. *And at 1/4 of their former costs.*

SEE PAGE 19 of the information-packed handbook, "What Petroleum Men Should Know to Simplify Cleaning," for complete details of cleaning and paint stripping storage tanks. This guide is loaded with facts that can help petroleum men realize greater savings in time and money on many maintenance cleaning operations. It's FREE on request. Write Oakite Products, Inc., 52-E Rector Street, New York 6, N. Y.

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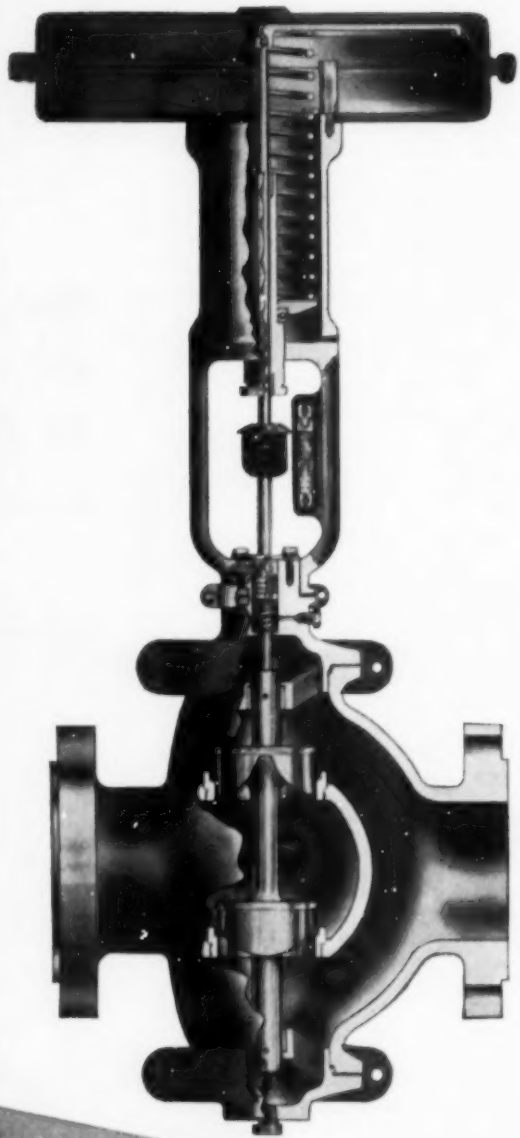

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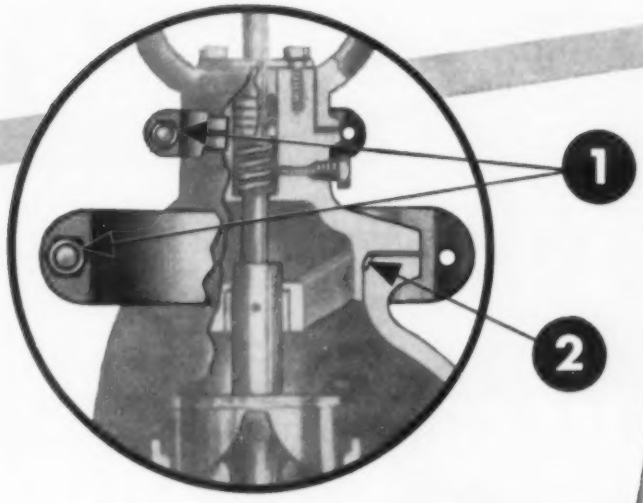

Exclusive New BS&B Features Include...

1 Newly Designed Clamp Ring

... Is used to seal top and bottom plates to valve body, and to integrate body and topworks assemblies into a single unit!

... Allows yoke orientation to any convenient operating position for observation and action!

... Requires only two bolts, avoiding use of multiple bolts and studs. Allows quick dis-assembly!

2 New All-Metal Float Ring Seal

... Employs a new design principle to provide an absolutely leak-proof positive closure!

... Tightens automatically as pressure increases within the valve. The higher the pressure — the tighter the seal!

... Automatically adjusts with changes in temperature!

... Eliminates the annoyance of gasket replacements!

OVER 60 YEARS
BS&B
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

work may actually reduce productive work. More seriously, it may force engineers out of the field altogether, as indicated by the Carnegie survey.

SAMUEL SCHIFFER
Design Engineer
Gulf Oil Co.
Pittsburgh, Penna.

• *We asked Author Kern to comment on Reader Schiffer's points, which he did as follows:*

"The first paragraph of Mr. Schiffer's letter refers to the science and engineering graduates who have deserted their field (the Carnegie Institute of Technology's findings) because of the mechanical approach to design work. (Mr. Schiffer's conclusion)...

"As an engineer I am puzzled by that 83% deserters. Have they all left their field because of the mechanical approach to design work and not for better pay elsewhere, or for any other reason? I think most of the problems in everyday design engineering suggest a "mechanized" solution. But even with a high degree of "mechanization" there is unlimited opportunity to exercise one's engineering talent.

"Some of Mr. Schiffer's points were made or answered in the article itself before he wrote his letter. Compare the second and third paragraphs of his letter and the first three paragraphs of Part 1 (the July article) with the following sentence: 'The two essential factors of efficient drawing production are speed and engineering accuracy.' That sentence is also from Part 1.

"I hope Mr. Schiffer does not suggest that design work is executed when detail drawings are produced. Figs. 1, 2 and 3 are detail drawings and are produced after the designers have already finished their plans. I have seen hundreds of well designed single line piping drawings and Mr. Schiffer's assumption of adding cost to fabrication and construction seems to me artificial. Engineering accuracy depends primarily on the designer's care and experience, and not on the method of drawing presentation.

"Mr. Schiffer's points are in extremes in the last two paragraphs of his letter. A designer's work cannot be clocked but design procedures can be 'assembly-lined,' answering his most extreme point.—Robert Kern."

• *Thank you very much, Reader Schiffer and Author Kern. An exchange of information of this nature, and to the extent to which you both discussed this point. We are sure all readers will have gained.*

New Copper Deactivator Guaranteed not to freeze!

This special all-weather UOP Copper Deactivator formulation will not freeze when stored for extended periods at temperatures down to 0° F. We call it Copper Deactivator-AW(50)*, since it contains active ingredient in 50% concentration. This new formulation completely eliminates the low temperature pumping problems common to other deactivators.

AW(50) gives maximum metal deactivating efficiency and economy. Improved color, too, and because of its better solubility and pumping properties, it can be injected directly into gasoline or other refinery streams without the customary dilution with aromatic spirits.

AW(50) is supplied in handy five-gallon containers for manual addition or blending with other additives and in 55-gallon drums for automatic injection systems.

*Trademark of Universal Oil Products Company

PRODUCTS DEPARTMENT

UOP

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(To obtain more data on advertised products see page 142)

PETROLEUM CHEMICALS DIVISION

NEWS

October ★ One of a Series of Bulletins for the Petroleum Industry ★ 1956

Merchandising Opportunities in Improved Oils

With the "super premium" gasolines so much in the news, there's an especially good marketing opportunity for premium motor oils.

Consider, for example, an oil with low-duty detergency for stop-and-go driving. The majority of American passenger-car driving consists of trips shorter than 10 miles. And more than 90% of all city bus, taxi and delivery truck operation is in stop-and-go city traffic. These low-power, low-temperature operating conditions, of course, are likely to result in excessive build-ups of engine sludge. This means that there is a considerable market for a new type of lube oil with low-duty detergency.

New polymeric additives

To give oil this property, Du Pont has developed two synthetic detergents... Lube Oil Additives 564 and 565. Both are ashless polymeric additives, slightly basic, that provide an economical and effective means of preventing engine oil sludge – particularly under low-duty, stop-and-go driving conditions. And these additives are effective V.I. improvers as well as detergents.

Any of our sales offices will gladly supply additional information, and a suggested promotion kit.

Additives prevent many oil-burner troubles

With the heating season just getting under way, many old familiar oil-furnace problems will be back to cut, unnecessarily, into fuel distributors' profits through another season.

Plugged nozzles, screens and filters; gel-clogged lines; ignition and stack control failures may all have been part of a day's work for distributors and servicemen last year. But this year can tell a different story. Here it is . . .

When heating-oil is sold on a service-contract basis, every service call costs the supplier money, obviously. This of course comes out of profits. Fortunately, however, many of these common headaches can be prevented with minute quantities of low-cost Du Pont additives.

To prevent sludge . . .

Du Pont Fuel Oil Additive No. 2 (FOA-2) is a double-action additive that works effectively both as a dispersant and as a stabilizer.

It minimizes the formation of insoluble residues. It also helps to rid dirty systems of sludge deposits previously accumulated, by reducing the size of the sludge particles so finely that they do not clog screens or nozzles. In this way, it can actually help reduce the man hours required for distributors' service calls.

Why many railroads prefer economy fuels stabilized with Du Pont FOA-2

Fuel specialists and purchasing agents of many railroads are taking a keen interest in the use of Du Pont Fuel Oil Additive No. 2 (FOA-2) for stabilizing all their economy grade diesel fuels.

Uniform results in a variety of different fuel stocks are a big reason.

Since diesel fuels—especially economy grades – vary widely in their response to additive treatment, you can readily see why such uniformity is an important advantage to the railroads which often have a number of different suppliers loading into the same tank.

After carefully testing economy fuels with a number of different additives for several years, it has been found that FOA-2 gives good results over the widest range of varying fuel stocks. Because of its outstanding stabilizing and dispersant action, FOA-2 helps to cut maintenance costs by relieving filter-plugging and injector-sticking problems. Moreover, the additive does not contribute to the sparking problem which may accompany the use of economy diesel fuels.

If you would like more detailed information about on-the-railroad results obtained with FOA-2, just get in touch with one of our representatives.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Heating Troubles*

To keep electrodes and stack controls clean . . .

As distributors well know, a number of burner failures are due to insulating deposits on the stack controls and ignition electrodes. Because FOA-2 is a nonmetallic, *ashless* additive, it leaves no deposit to insulate electrodes . . . or to interfere with the operation of control mechanisms.

Du Pont FOA-2 helps prevent nozzle plugging

To prevent gel-clogged lines

Du Pont Metal Deactivator (DMD) can be used effectively to prevent *copper* fuel lines and filter screens from playing mischief with the chemical composition of heating oils. When unchecked, the copper is likely to cause the formation of a gelatinous substance . . . and complete stoppage of fuel flow.

DMD can be economically used in combination with FOA-2. When the two additives are combined, the DMD frequently carries part of the stabilizing load—thus reducing the amount of FOA-2 that is needed for sludge prevention.

For best results

FOA-2 and DMD should be added to freshly prepared stocks at the refinery. For more detailed information on the use and performance of these additives, just get in touch with one of our representatives at any of the sales offices listed below.

ASSISTANT DIRECTOR IN CHARGE OF PRODUCT EVALUATION

Dr. Robert H. Blaker joined the Du Pont Petroleum Laboratory in 1953 as research supervisor, became head of the Combustion Division in 1954 and was appointed assistant director in charge of product evaluation in February of 1956.

Dr. Blaker joined Du Pont in 1950 as research chemist at Jackson Laboratory, where he also served in the Petroleum Division, after an initial assignment in synthetic fiber dyeing.

Berea College awarded Dr. Blaker an A.B. degree in chemistry in 1942. He also attended M.I.T. and received his Ph.D. in physical chemistry at California Institute of Technology in 1949. Dr. Blaker also studied in Britain under an Imperial Chemical Industries grant.

He is a member of the Society of Automotive Engineers and the Petroleum Division of the American Chemical Society.

DR. ROBERT H. BLAKER

New findings on fuel performance in high-compression engines

How much will compression-ratio increases boost octane requirements?

Not necessarily as much as has been generally thought—according to the results of recent studies at the Du Pont Petroleum Laboratory.

Our tests showed that the engine-design, fuel and lubricant, *all* have a significant bearing on engine-performance. This indicates that octane requirements of high-compression engines can be kept at a minimum by careful attention to *each* of these three factors.

A surprising development was noted in one car operated at an 11:1 C.R. Running under normal conditions, this car was found to be free of combustion noise, even on a 100 octane fuel.

It was found that the 90% distilled point is not necessarily the criterion for measuring deposit-harm of fuels. This can mean that there will be more latitude in blending the components for high-compression fuels; more heavy ends may be used in this type of fuel, without detrimental effects on the engines.

The tests also indicate that octane requirements of high-compression engines can be reduced by improvements in lubricants and through engine design.

A paper with full details on this testing program was recently presented at the API Refining Meeting in Montreal. Just drop us a line if you would like a copy.

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A-2718

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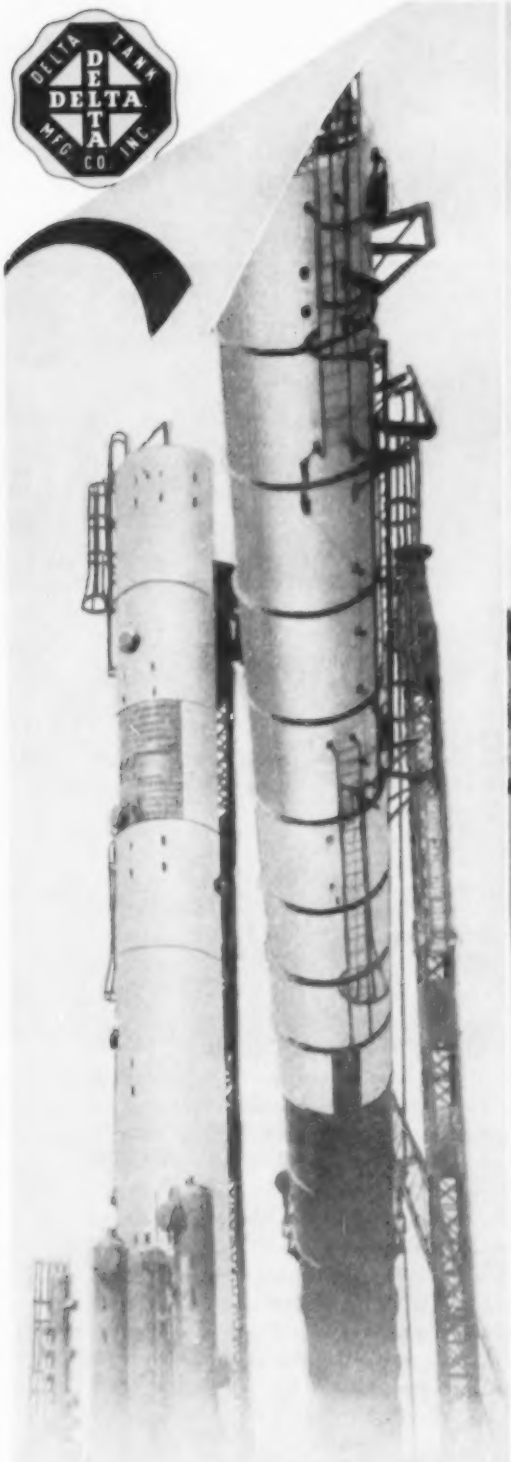

You should see what's inside!

If it were possible to see inside, the engineering skill and fabricating experience involved would be apparent. This 186-foot, 396,000-lb. tower is one of seven fabricated by Delta Tank for the American Cyanamid Company.

Delta's modern facilities are geared to produce the type of pressure equipment needed by the chemical, petro-chemical and petroleum industries. Delta's Baton Rouge plant is located right in the heart of the great new Gulf petro-chemical area.

Complete information on Delta's facilities, or your specific equipment needs, is available at your request.

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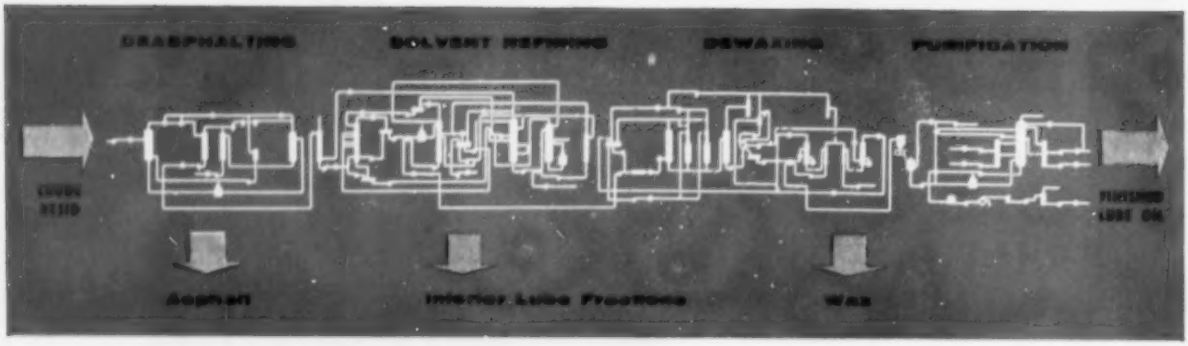
lube oils



Foster Wheeler experience points the way to lower cost production

Complete lube oil plant, designed and constructed by Foster Wheeler at England's largest refinery. Process units, in sequence from right to left, are as follows: propane deasphalting, phenol extraction, propane dewaxing and clay contact-vacuum rerun. Foster Wheeler is now building complete lube plants in the United States, Iraq and Venezuela.

NEW ADVANCES in refining processes and equipment have resulted in substantial increases in the overall efficiency of lubricating oil production—contributing to higher sustained output of high quality oils at lower unit production cost.

In the construction of new lube oil plants or modernization of existing facilities, Foster Wheeler's long experience in this specialized field is your best assurance of complete satisfaction, from initial planning to final installation and on-stream service. Foster Wheeler process design engineers offer more than 20 years of continuous and cumulative experience in lube oil manufacture. Their intimate knowledge of all phases of design, engineering and construction—plus their close relationship with all licensor companies—can save time, effort and expense in any expansion or modernization program. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

(To obtain more data on advertised products see page 142)

Sinclair-BAKER

RD 150

"...MOST EFFICIENT PLATINUM CATALYST FOR HIGH OCTANE OPERATIONS..."

BAKER'S RD 150 has proved to be the most efficient of all platinum catalysts, *especially* so for high octane operations. It assures important yield increases at high octane levels . . . exceptionally long periods of operation . . . and *regeneration in situ!* The total result is a unique combination of telling advantages that facilitate production quality, quantity and operating efficiency at the lowest cost level.

RD 150 is a joint development of Baker & Company, Inc. and Sinclair Research Laboratories. It is now being used in successful production by such companies as Sinclair, Socony and Pure Oil.

The very extensive facilities for manufacture and refining in modern Baker plants provide full assurance of prompt deliveries and service. The complete RD 150 story will be interesting to you.

A Baker representative will be glad to give you detailed information upon request.

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BAKER
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CATALYSTS

THE HUB OF PLATINUM METALS RESEARCH

CFC COMPLETE FILTRATION COVERAGE

there's a Commercial Filters unit engineered for your filtering job...

Fulflo FILTERS

Fulflo Filters provide optimum clarity at ultra-high flow rates. For all industrial fluids—including oils, liquid fuels, chemicals, water, compressed air and various gases. Sizes to handle flow rates up to 1,600 gpm. Pressures to 4,000 psi.

Fulflo Filters feature Honeycomb Filter Tubes, the "precision controlled density" element that filters every drop again and again to give you microscopic clarity. Choice of cotton, acetate, nylon, orlon, dacron, dynel or glass fibres.

Standard models available in steel, stainless steel, rubber lined steel or nickel-plated brass. Custom models engineered to special requirements.

Honan-Crane FILTERS

Honan-Crane Filters offer "clean oil" filtration in diesel, turbine, hydraulic, metal-working and quenching operations. Bulk refill models provide depth filtration with cellulose medium for additive oils and Cranite (fullers earth) medium for straigth mineral oils. Multi-cartridge models feature six different types of cartridges that may be used interchangeably depending on type and degree of filtration desired. Flo-Pac models, installed in line, handle flow rates up to 900 gpm. All have quick-opening covers for ease in changing refills.

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FILTERS Michiana

Diesel and gasoline engines get complete protection against the damaging effects of dirty oil with Michiana Lube and Fuel Oil Filters. Designed for low cost filtration and proven in thousands of installations. "Throw-away" or repackable filter elements. Available in a wide range of sizes and models.

Write for literature or engineering help covering your filtration problem.

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COMMERCIAL FILTERS CORPORATION

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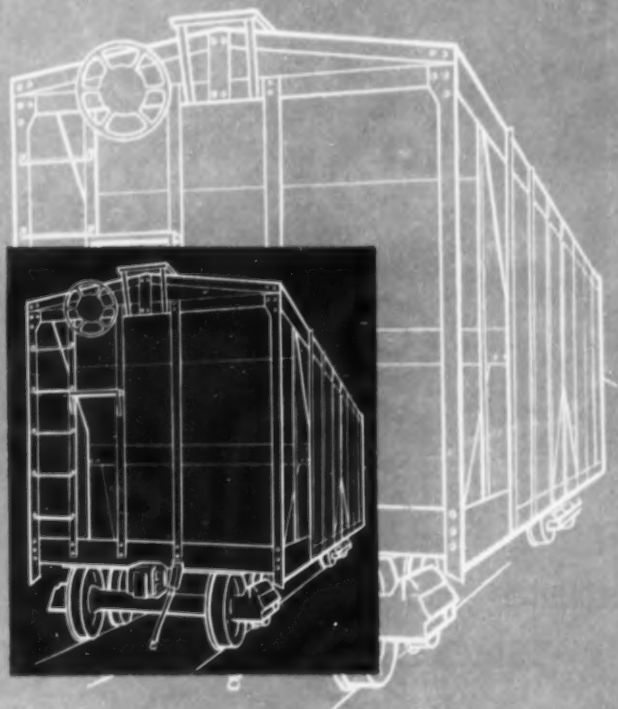
Now From Westvaco

Increased Production of Barium Chemicals



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We have increased by 30% our output of Barium Oxide and improved its high quality at the same time with a new, exclusive process developed by Westvaco engineers.

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. . . pioneered electric-furnace reduction of dense, crystalline Barium Oxide with particle-size adjusted to the user's requirements.

. . . developed more soluble Barium Octahydrate and Barium Pentahydrate in flake form.

. . . initiated bulk shipment of Barium Alkalis in covered hopper cars to serve large users.

Now with increased production, plus recently doubled electric furnace capacity and new mineral reserves, we are well-prepared to meet the anticipated growth in demand, particularly by makers of lubricating oils. We welcome the opportunity to work with prospective users.

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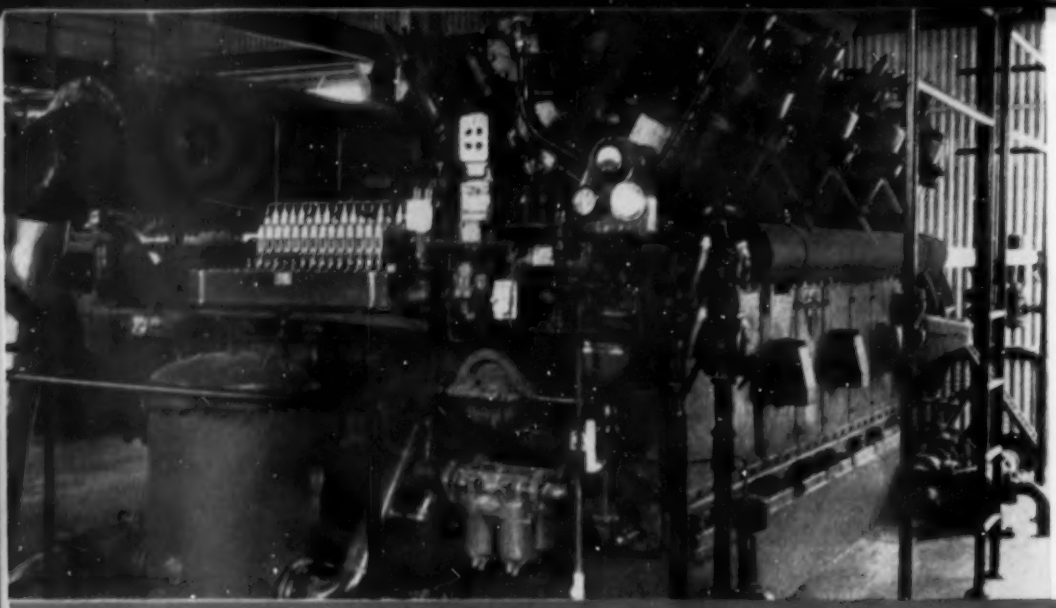

One of the 8-cylinder GMXA's compressing low pressure gas for the production of propane, butane and gasoline in the Little Beaver "dry" gasoline plant.

Another example of efficient power, at lower cost

This modern plant in the Denver-Julesburg Basin contains eight Cooper-Bessemer 500 hp GMX-A's totaling 4,000 reliable compressor horsepower.

In the Denver-Julesburg Basin . . . multiple service . . . . multiple advantages with portable **COOPER-BESSEMERS**

• Offering unmatched economy in all phases of operation . . . Cooper-Bessemer GMXA compressors efficiently handle eight to ten million cubic feet of low pressure gas per day in the Little Beaver "dry" gasoline plant, Morgan County, Colorado.

Operated by Continental Oil, and owned by a number of companies, this plant in the Denver-Julesburg Basin is connected to a system of 169 wells. Six portable GMXA's, rated 500 hp at 400 rpm, handle three stage gas compression from 1 to 865 psig. Two additional Cooper-Bessemers are used for refrigeration and recompression service.

If your future plans include engines or compressors in the 200 to 5000 hp range . . . for the usual, or the very unusual . . . you'll profit from a call to the nearest Cooper-Bessemer office. Cooper-Bessemer equipment has long been recognized for handling *all* types of jobs with minimum difficulty and continuing economy, even after many years of severe service.

ENGINES: GAS • DIESEL • GAS-DIESEL COMPRESSORS: RECIPROCATING AND CENTRIFUGAL, ENGINE OR MOTOR DRIVEN

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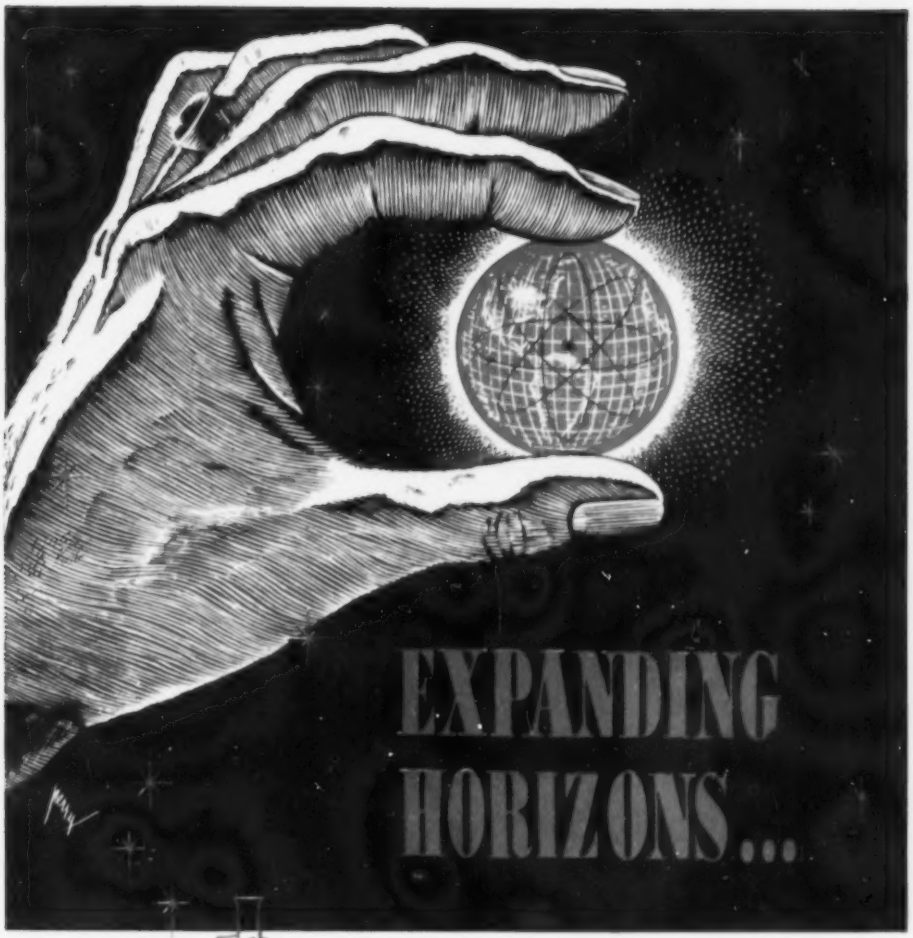

The REFINERY ENGINEERING Company's horizons are greatly expanded. Treco is now in position to offer engineering, design and construction of refineries, chemical plants, ore processing, secondary recovery and gas processing facilities on a world-wide basis.

The company has greatly enlarged engineering resources, research and development laboratories and a rapidly expanding staff. This enables The REFINERY ENGINEERING Company to offer a *complete service* to nearly all types of industries.

Treco has just produced a brochure which shows the Company's facilities with photographs of completed projects. A copy will be mailed you promptly upon request on your company's letterhead.

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Looking for something special in materials?

Norton high-purity, high-stability materials aid in solving many industrial problems

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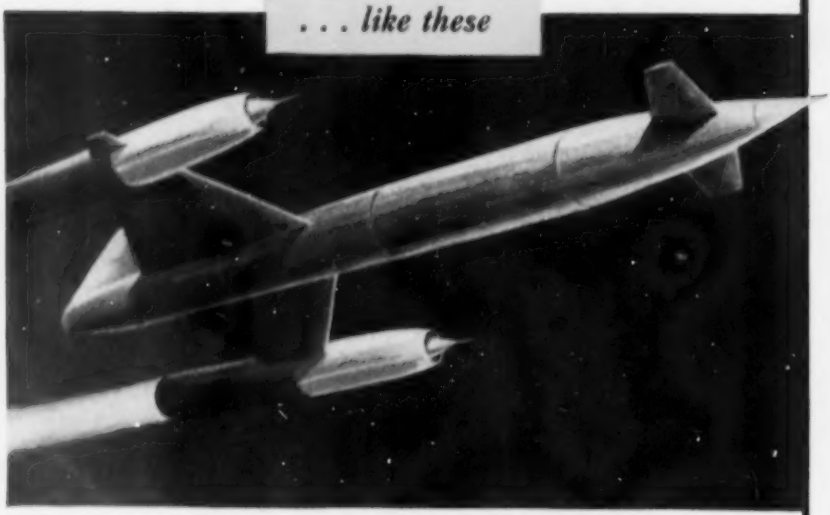
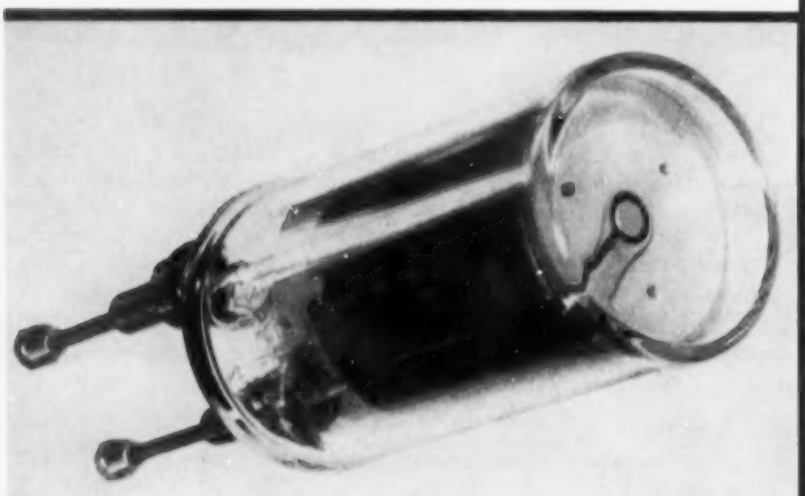


In Supersonic Flight. Marquardt Aircraft Company of Van Nuys, Cal., uses Norton ROKIDE* protective coating in its new, highly advanced ramjet engines for supersonic missiles. The flame-sprayed ROKIDE aluminum oxide coating greatly increases the tailpipe's resistance to excessive heat and erosion. Other ROKIDE coatings for high temperature applications include "ZS" zirconium silicate and "Z" stabilized zirconia.



In Concentrated Light. After inventing their outstanding new RF induction lamp, Sylvania Electric Products Inc. turned to Norton Company as a dependable source of high-melting, stable materials. Norton tantalum carbide was selected as the light-emitting source. Heated to a much higher temperature than tungsten filaments can stand, this material becomes the most uniform concentrated light source ever developed.

If lack of suitable materials is delaying development or improvement of your products, remember this:

Norton high-melting, fusion-stabilized materials have helped solve many such problems for manufacturers, in applications ranging from home appliances to guided missiles and atomic energy equipment.

Here is a partial list of Norton refractory materials: ALUNDUM* fused alumina, CRYSTOLON* silicon carbide, MAGNORITE* fused magnesia, NORBIDE* boron carbide, fused stabilized zirconia, special fused oxides, refractory carbides and borides.

Another point to remember: these materials offer you combinations of thermal, electrical and physical characteristics not available in the usual refractory substances. Melting points range up to 6400°F. Electrical resistance and thermal conductivity run from low to very high. NORBIDE boron carbide, with a Knoop hardness of 2800, is the hardest commercial material made by man.

Norton high-melting materials are the basic ingredient of the famous Norton Refractory Rx's — refractories *engineered and prescribed* for the widest range of industrial uses. Norton Company supplies them in crude, processed or fabricated form, and will work with you in engineering them to your requirements. For further information, write to NORTON COMPANY, Refractories Division, 269 New Bond Street, Worcester 6, Mass.

NORTON

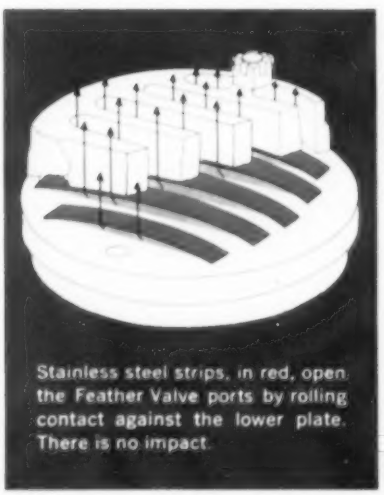
REFRACTORIES

Engineered... Rx ...Prescribed

Making better products... to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels
Grinding Machines • Refractories
BEHR-MANNING PRODUCTS: Coated Abrasives
Sharpening Stones • Behr-cat Tapes
*Trade-Marks Reg. U.S. Pat. Off. and Foreign Countries

This compressor valve works with no impact for longer life, best efficiency



Stainless steel strips, in red, open the Feather Valve ports by rolling contact against the lower plate. There is no impact.

The Feather* Valve is the lightest, simplest, quietest compressor valve ever developed. Flexible strips of stainless steel open and close the valve ports with a gentle rolling contact. There is no destructive impact . . . even when the valve is operating as fast as forty times a second.

This lack of impact assures long life and negligible maintenance. The valve itself is all but indestructible. Absence of buffer plates and cushioning devices give it extreme simplicity.

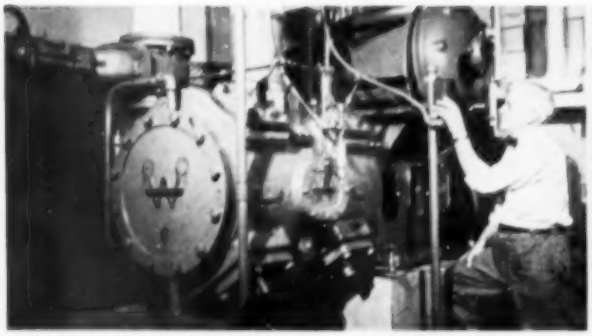
The Feather Valve is quiet and reliable because of its lightness and tight contact seating. Valve action is very sharp. There is virtually no slip or back flow. As a result, you get minimum valve loss and use minimum power.

To get the utmost in performance, be sure you specify Worthington when you buy your next compressor. Worthington Corporation, Harrison, N. J. K-6.2

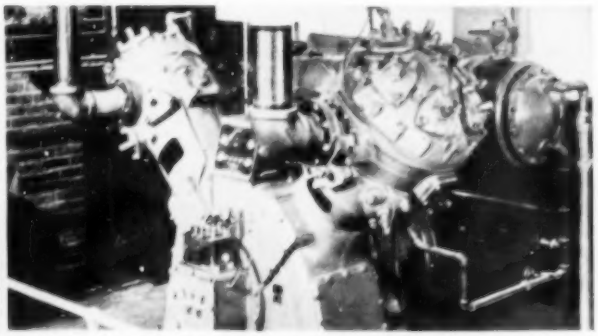
WORTHINGTON

*Reg. U. S. Pat. Off.

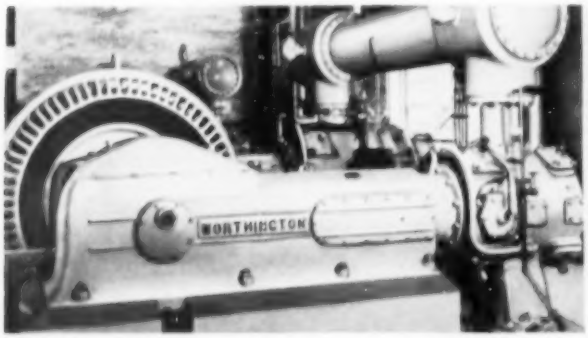
No compromising machine selection with this complete compressor line



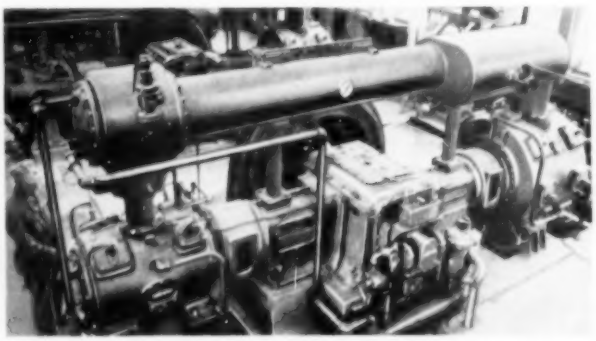
Single-stage compressor, type HB. For economical, continuous supply of air in smaller quantities. Sizes range from 10 to 125 hp. (Bulletin L-640-B1C)



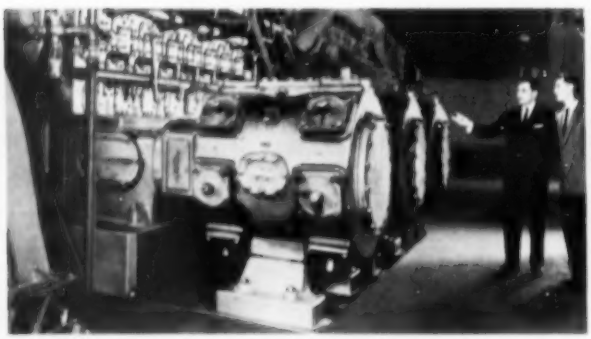
Two-stage angle compressor, type YC. Most compact unit for its capacity. Available up to 250 hp, and in larger sizes in similar type DYC. (Bulletin L-676-B1A)



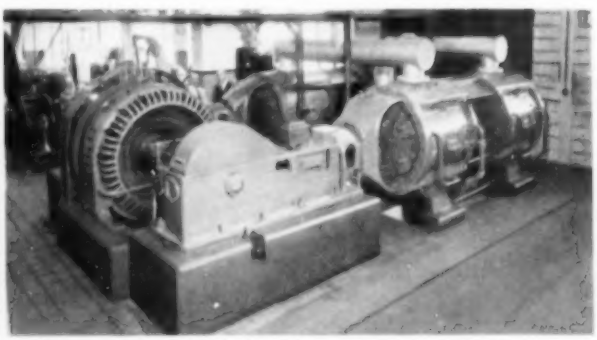
Horizontal duplex compressor, type DC-2. A two-stage compressor designed for heavy-duty service. From 250 to 3,000 hp. (Bulletin L-675-B1B)



Balanced opposed compressor, type BDC. Versatile—ideal for either multiple or single-service applications. Sizes from 300 to 10,000 hp. (Bulletin L-679-B1)



SUTC gas-engine compressor. Most complete process flow flexibility with 2-cycle compactness. Available in ratings from 750 to 2,500 hp. (Bulletin S-550-B23D)



Vacuum pump. This Worthington "compressor in reverse" provides pressures as low as .25 psia. Available in sizes from 10 through 2,500 hp. (Bulletin L-600-B9-4)

A compressor and drive for your every compression job is available in the standard Worthington line. Sizes range up to 10,000 hp, air and gas pressures to 35,000 psi. For more information about any of these Worthington compressors, write to Section K64, Worthington Corporation, Harrison, N. J. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont.

K-6.4

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At present, M. W. Kellogg's engineers, metallurgists and others give a considerable part of their time to over seventy such activities . . . ranging from boiler and pressure piping codes to welding practices and radiographic testing techniques. Many of today's accepted design concepts were introduced to the engineering profession by Kellogg committee men.

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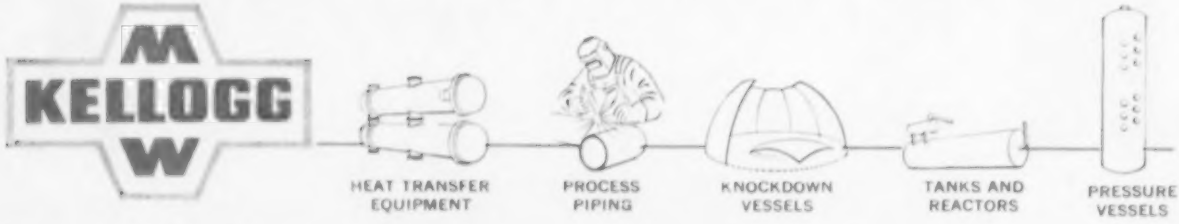

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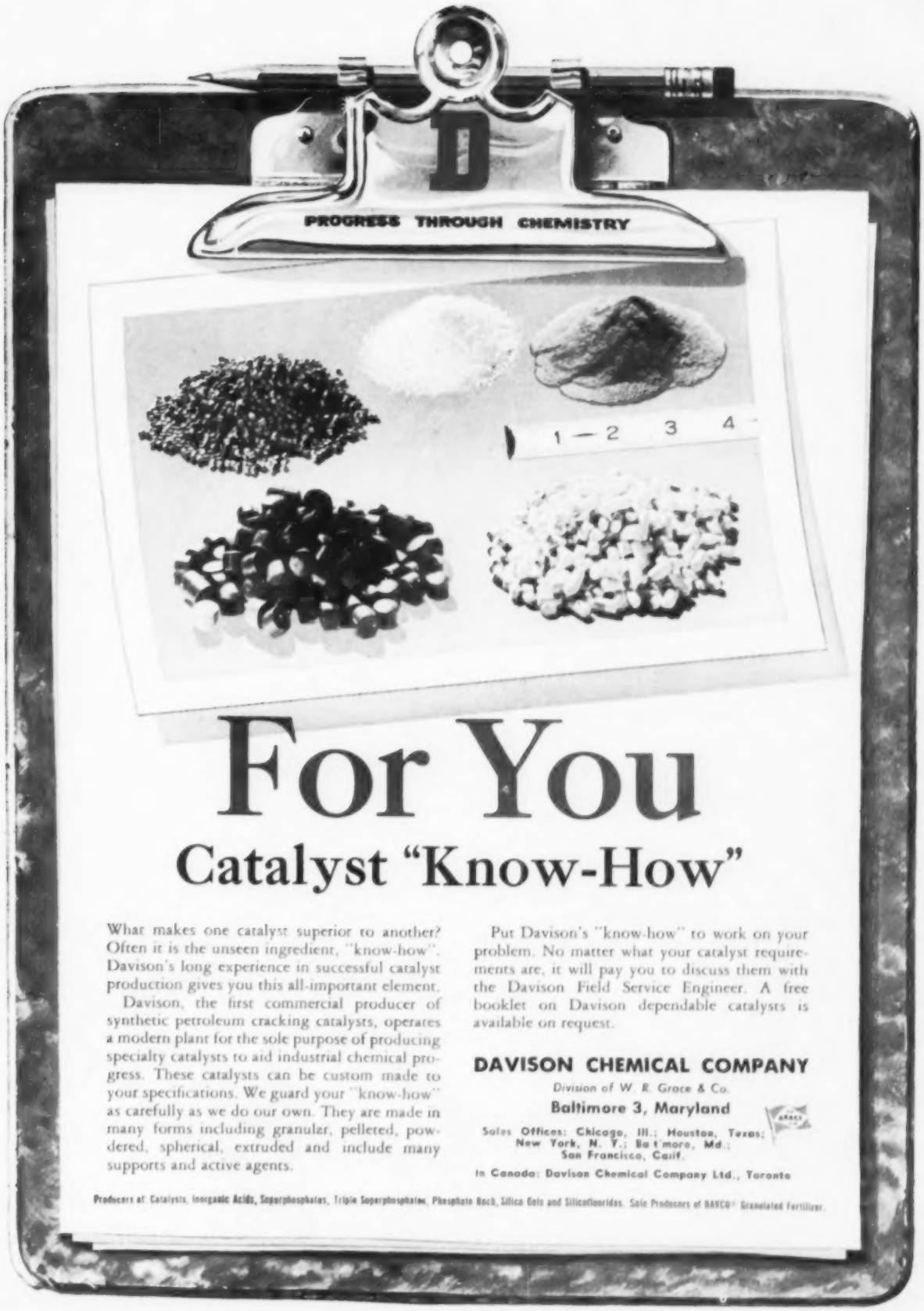

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Put Davison's "know-how" to work on your problem. No matter what your catalyst requirements are, it will pay you to discuss them with the Davison Field Service Engineer. A free booklet on Davison dependable catalysts is available on request.

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The new HOUDRY ISO-PLUS Process combines the proved advantages of catalytic HOUDRIFORMING with other processes to economically reform low-octane naphthas into gasolines with octane ratings in excess of 100-octane F-1 clear. This catalytic reforming process offers refiners practical approaches to higher octanes at relatively low investment.

High-Octane Alternatives with ISO-PLUS HOUDRIFORMING

ISO-PLUS Aromatics Extraction Combinations

1. Iso-Plus Houdriforming with separate Houdriforming of paraffinic raffinate

2. Iso-Plus Houdriforming with recycling of paraffinic raffinate

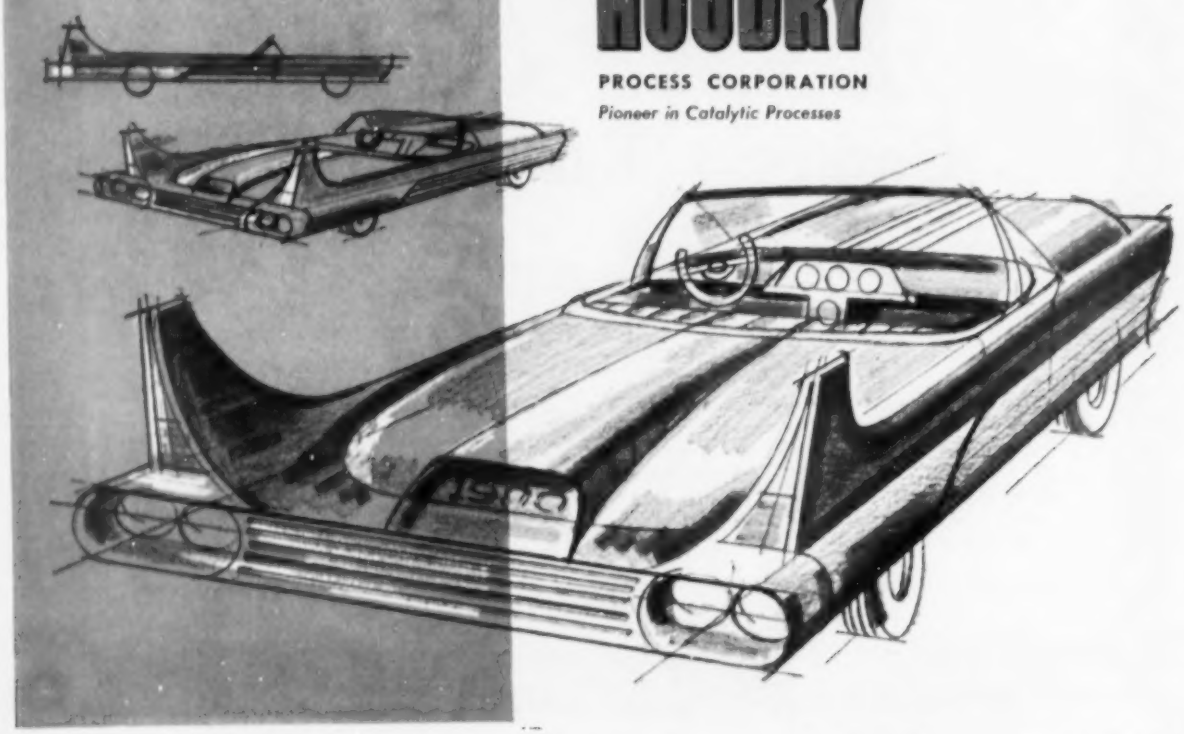
Variations of the Iso-Plus Process employing aromatics extraction have produced yields of 100-octane gasoline, F-1 clear, of up to 91% of naphtha charge. Slight changes in operation permit refiners to further increase gasoline product octane.

ISO-PLUS Thermal Processing

3. Iso-Plus Houdriforming with thermal reforming of Houdriformate

With thermal reforming as the supplementary process, Iso-Plus processing yields 80% to 90% of reformed gasoline, depending upon the desired octane rating of the final product. This operating scheme is especially attractive to refiners with available thermal reforming equipment.

For further information, write to Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa.



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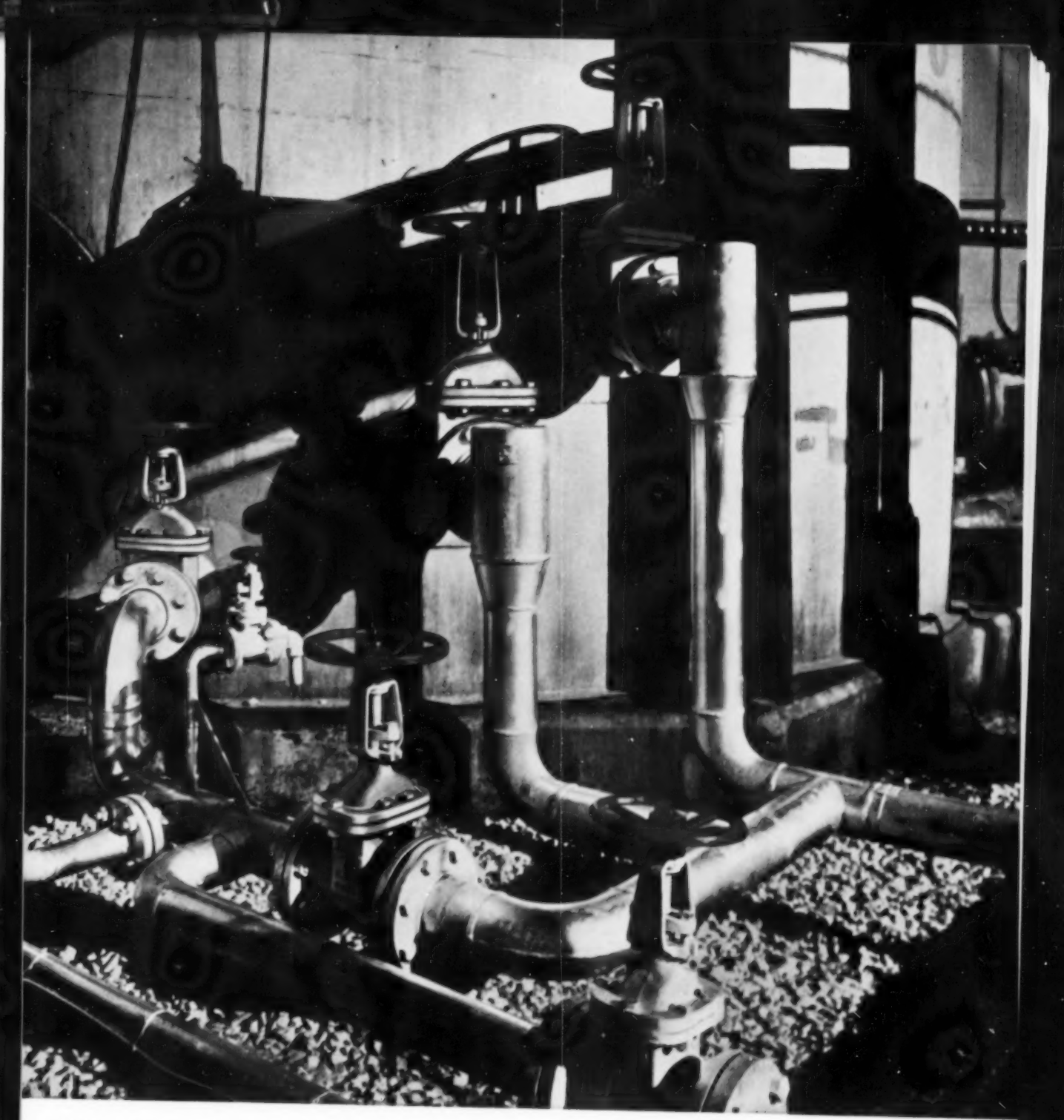


Meet three synthetic detergent experts

You're looking at a Philadelphia installation of The Atlantic Refining Company (expert #1).

Ultrawet, an important ingredient of synthetic detergents, is the product being processed in this modern plant designed and built by The H. K. Ferguson Co. (expert #2).

Helping to prevent contamination of the product due to corrosion are long-lasting, red-wheeled valves made by Aloyco (expert #3). Made of corrosion-resistant Aloyco 20, the gate and globe valves used here handle a 98% concentration of sulfuric acid at up to 180° F.

Whatever your process, whichever corrosives you need to keep in line, it pays to check first with Aloyco. As the world's largest manufacturer of corrosion-resistant valves exclusively, we're most likely to have the valve you need. Write Alloy Steel Products Company, Inc., 1301 West Elizabeth Ave., Linden, New Jersey. 63

Longer Lasting
ALOYCO
VALVES
FIRST IN CORROSIVE SERVICE

Subsidiary of Walworth Company

CONDENSER TUBE CLINIC

Edited by **ARTHUR W. TRACY**, Metallurgical Engineer,
The American Brass Company, Waterbury, Conn.

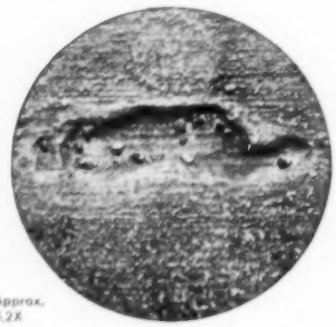
Choose the right alloy for your condenser tubes

LONG condenser tube life depends on the proper choice of alloy as well as conditions of operation.

Fresh inland cooling water normally does not cause corrosion problems; either ANACONDA Arsenical Admiralty-439 or ANACONDA Phosphorized Arsenical Copper-108 tubes will give long service. ANACONDA Ambronze-421 tubes have been found more durable for river waters polluted with acid coal-mine drainage.

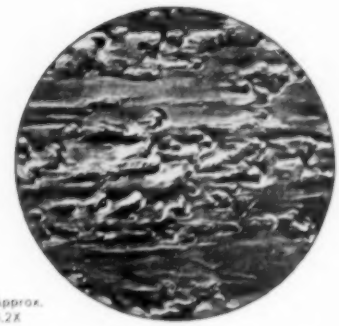
Sea water is usually more corrosive than fresh water. Clean sea water flowing turbulently, especially when air bubbles are present, causes inlet-end impingement pitting. Lowering the velocity, with subsequent smoother water flow, will solve this problem; but such a solution is not always economically feasible. ANACONDA Ambraloy-927 tubes are definitely more resistant to impingement corrosion than are admiralty metal tubes. Where water velocities are relatively high, ANACONDA Cupro Nickel, 10%-755 tubes can be expected to give even better service. ANACONDA Cupro Nickel, 30%-702 tubes are considered for the highest water velocities normally encountered in exhaust condensers.

Sea water in harbors and at river inlets is often polluted with decomposing organic matter which may settle in condenser tubes and cause deposit pitting. Hydrogen sulfide, a product of the decomposition, is also an important factor in corrosion by polluted waters because poorly protective scales containing metallic sulfides are formed. Chlorinating polluted waters is helpful in preventing deposit attack. Frequent removal of debris by brushing is an important factor in increasing tube life. Ambraloy-927 tubes generally give long service handling polluted sea water. In some cases, either Cupro Nickel, 10%-755 or Cupro Nickel, 30%-702 have served best because they are more resistant to deposit pitting.



Approx. 5.2X

DEPOSIT PITTING in uninhibited Admiralty Metal tube from a tidewater power station condenser. In this case a deposit of paper pulp is believed to have shielded a small area, forming an oxygen-concentration cell. The shielded area—low in oxygen content—is anodic and corrodes. Surrounding areas in contact with the solution high in oxygen form the cathode. Since the potential between the two areas is quite small, deposit pitting is usually a slow process.



Approx. 3.2X

IMPINGEMENT PITTING in an Admiralty Metal tube from the main condenser of an oil tanker. Excessively high water velocity caused turbulence, which carries away metal ions so that a protective film cannot form. An ion-concentration cell is formed, with the low-ion impinged area anodic; the areas where streamline, undisturbed flow persists, being cathodic. Air bubbles, water velocity, hydrostatic pressure drops in the tube, and alloy content, are all factors in this problem.

Some ANACONDA Condenser Tube alloys especially resistant to pitting, and their nominal compositions

	Arsenical Admiralty -439	Ambraloy -927	Ambronze -421	Cupro Nickel, 10% -755	Cupro Nickel, 30% -702
Copper, %	71	77	88	88.35	68.90
Nickel, %	—	—	—	10	30
Zinc, %	27.96	20.96	10	—	—
Aluminum, %	—	2	—	—	—
Tin, %	1	—	2	—	—
Arsenic, %	0.04	0.04	—	—	—
Iron, %	—	—	—	1.25	0.50
Manganese, %	—	—	—	0.40	0.60

TECHNICAL ASSISTANCE—Your tube problem may require special consideration and analysis. We are always ready to help with such problems and advise in the selection of the right alloy to give the best service. Write for the new edition of our Publication B-2 on "Anaconda Tubes and Plates for Condensers and Heat Exchangers." The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5677

ANACONDA®
Tubes and Plates for Condensers and Heat Exchangers

(To obtain more data on advertised products see page 142)

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FOR PETROLEUM REFINERIES
CHEMICAL PLANTS • POWER PLANTS

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Hard faced seats, in combination with precision finished, selectively hardened discs and wedges give these valves amazing resistance to erosion, corrosion and galling. That's why they are setting new standards of performance in steam, water, oil, or gas services at the recommended pressures and temperatures.

Get longer, drop-tight, service life with minimum maintenance by specifying Vogt G P Valves. Available in a complete range of sizes from ¼" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F.

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DROP FORGED STEEL

VALVES

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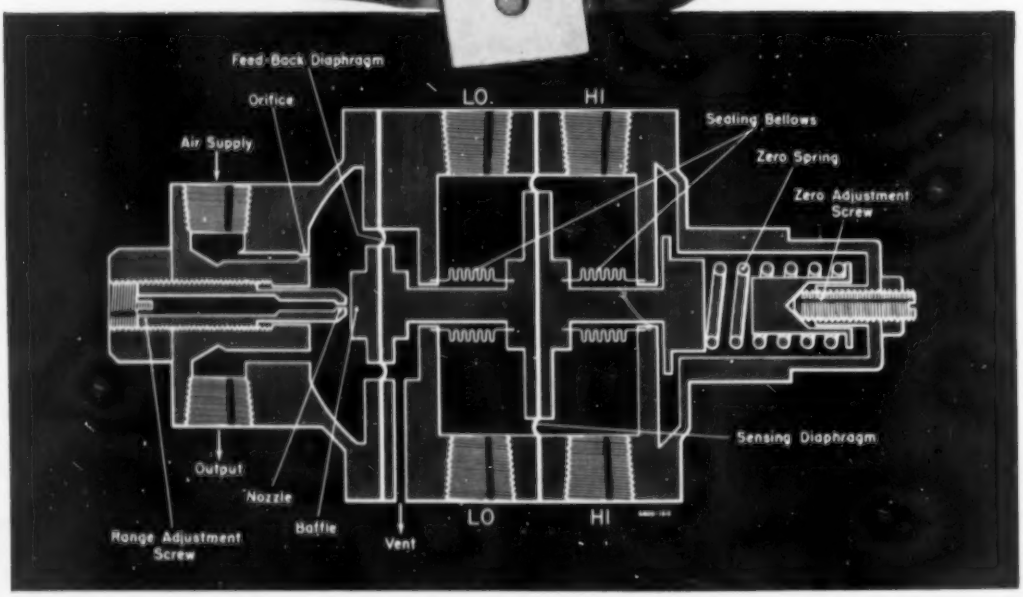
Taylor Presents

ACTUAL SIZE 6½" x 3"

No. 200TD111



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NEW LOW COST FLOW TRANSMITTER

The new Taylor Fixed Range Differential Pressure Transmitter (200TD111) provides an excellent, economical means of measuring flow, liquid level, or pressure. A 3 to 15 psi signal is transmitted to an indicating, recording or controlling receiver with an accuracy of 1%. Its remarkably low price makes it a practical cost accounting aid for many applications previously considered marginal. Check these features:

Simple to install. Piping is simplified because it can be close coupled to orifice flanges. Can be lead-line or bracket mounted. No seal pots required. Mercuryless, no leveling required. Force-balance construction means negligible displacement. 4½ lb. weight, 6½" x 3" size make it easy to handle.

Easy to maintain. External zero and range adjustments. Self draining or venting. Over-range to full working pressure with no permanent damage. Purges, if required, can be installed to keep body swept clean. Minimum number of parts.

Reliable accuracy. Calibration accuracy is better than 1%. Unaffected by piping or mounting stresses. No errors build up during operation because of self draining and venting feature. Pressure effect 2%/150 psi (100" range). Temperature effect 2%/100°F. (100" range). Sensitivity exceeds 0.1%.

Rugged and dependable. No stuffing box, levers or pivots. No relay valve. Compact, weatherproof, built for rough service and outdoor mounting.

Adaptable. Ranges 0 to 50, 100, 200 and 300 inches of water—easily and quickly changed by substitution of range ring and diaphragm.

No. 200TD111, Fixed Range Differential Pressure Transmitter. Immediate Delivery from Stock.

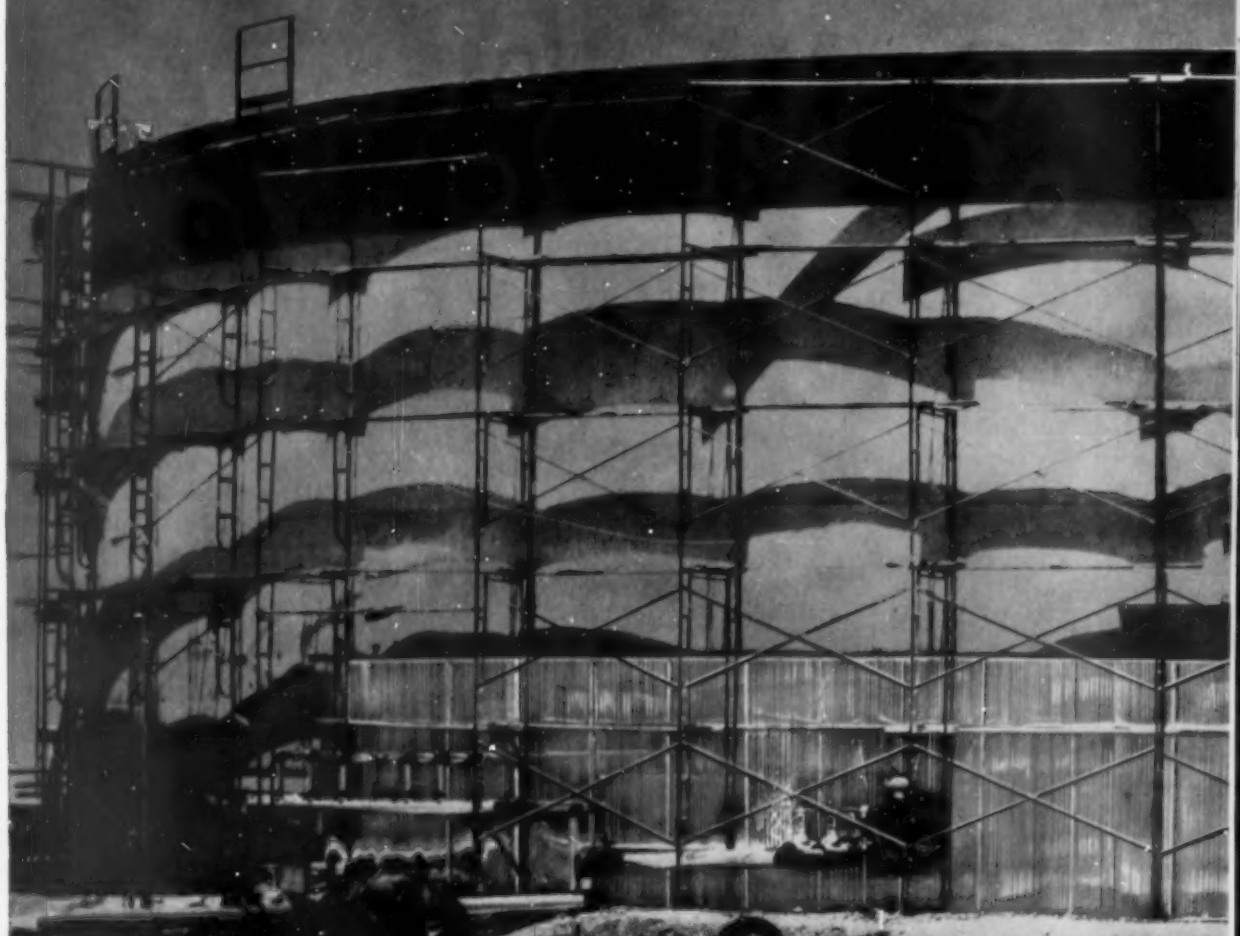
Call your Taylor Field Engineer to discuss possible applications for this remarkable new instrument in your plant. And write for **Bulletin 98274.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

DESIGN SPECIFICATIONS

Diaphragm of Neoprene impregnated Nylon.
Body material brass.
Maximum working pressure 150 psi.; temperature 150°F.
Air Supply pressure, 20 psi.
Air consumption, 0.10 standard cu. ft. per minute.
Output pressure range 3 to 15 psi.
Size 6½" x 3", Weight 4 lbs. 9 oz.
All connections ¼" internal NPT.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

The bigger they come the more you save with ULTRALITE



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Many successful application techniques have been engineered and all of them save you time, heat and dollars. Write today for complete information on different ways to "wrap your tanks and reap the savings" with ULTRALITE. **MATERIAL IS AVAILABLE FROM YOUR LOCAL ULTRALITE DISTRIBUTOR LISTED BELOW.**

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Thermal and acoustical insulations • Molded glass fiber pipe insulation • Pipe couplings and fittings

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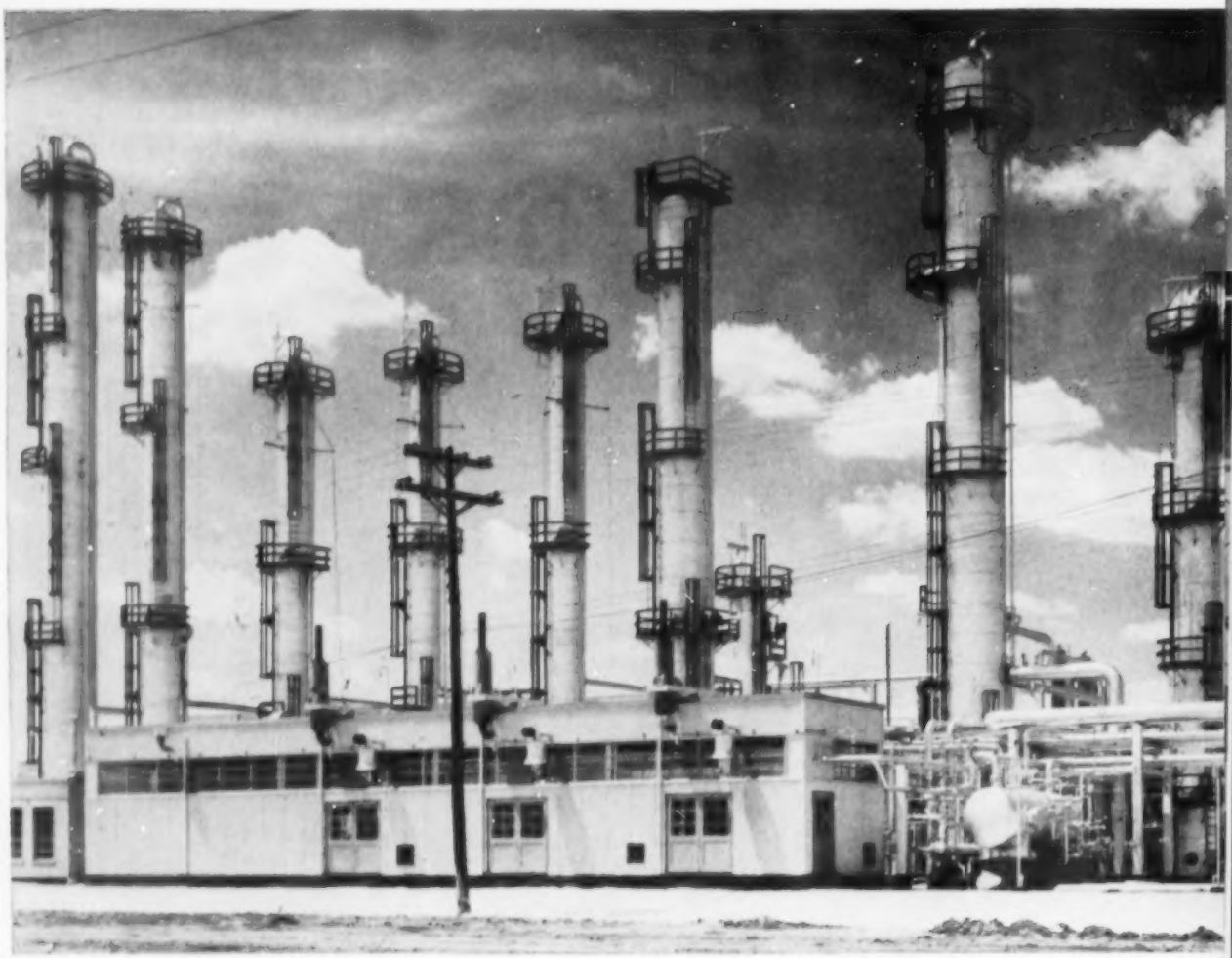
PROCON BUILDS UOP REXFORMING UNIT FOR COSDEN IN RECORD TIME

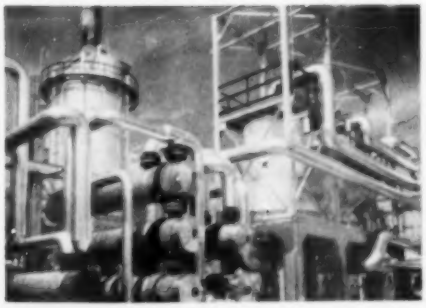
Another important oil refinery construction achievement for Procon



New Rexforming unit at Cosden just after going on stream

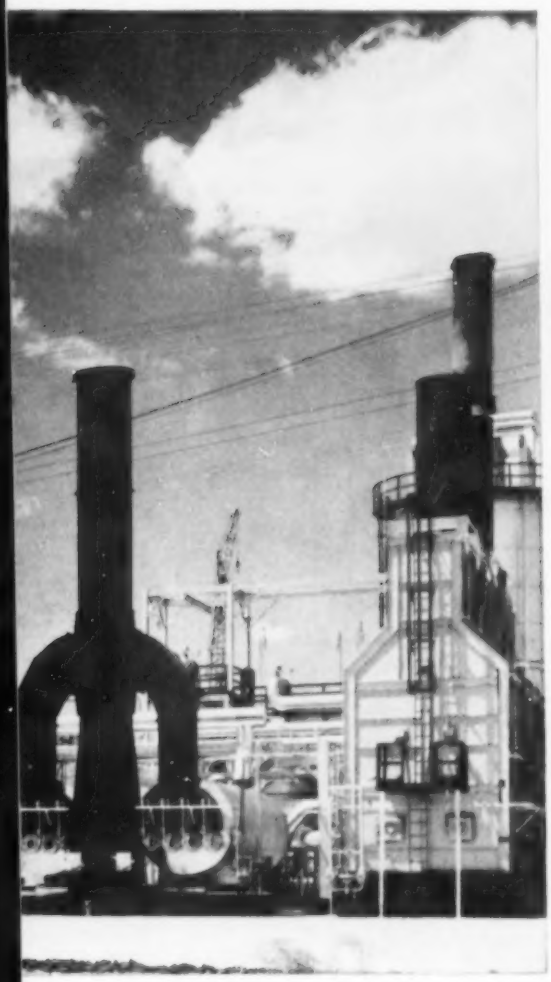
Ray Tollett, President (center) and Dan Krausse, Manager of Production (left) of Cosden congratulate Martin McReynolds, Field Construction Superintendent for Procon

This control room directs the operation of the Rexforming unit



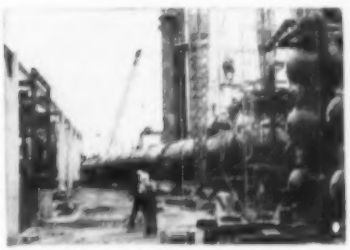
The heart of the Rexforming unit, the Reactors

Some months ago, Cosden Petroleum Corporation, Big Spring, Texas, gave Procon the responsibility of building their new Rexforming refining unit. Cosden's requirements for the construction specified completion "at the earliest possible time". Procon finished this project, the first Rexforming unit anywhere in the world to be built wholly from the ground up, in approximately six months. It is an outstanding example of Procon's ability to meet the most exacting construction requirements on time and right up to every specification.



Site 30 days after ground breaking

Ground was broken for the new Rexforming unit on January 18, 1956 and completion was promised in approximately six months. In order to meet this time requirement, Procon engineers realized it was necessary to break away from routine methods and use every time-saving method possible consistent with good construction practice. Accordingly, it was decided to proceed as far as possible with the basic construction even before the major columns could be finished and placed in position. This presented a delicate problem since, as the columns were completed and delivered, it was necessary to move them into position with the rest of the construction being ahead of the usual status for their easy installation. This was handled without flaw by the Procon construction crew on the job and the new unit went on stream just 190 days after ground had been broken.



Column just fits in space between partly completed construction

Column is carefully maneuvered into place

One of the principal problems was the positioning of the extractor column, RXV10, the largest in the unit. It had to be fitted carefully into the half-completed construction and maneuvering it into position in a space that permitted only a few inches leeway was an unusually competent construction accomplishment.

Procon offers a complete engineering service for the oil refining, petrochemical and chemical industries. When you give the job to Procon, you can be sure of completion on time and up to every specification.

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(To obtain more data on advertised products see page 142)

CARTRIDGE SEAL slides off mixer shaft, which uncouples to permit removal. New cartridge goes in its place. Taper on shaft insures correct alignment when recoupling.

Cut mixer maintenance 60%
with this cartridge-type *rotary seal*

Stops leakage! Runs years without adjusting! Slides off for fast, easy replacement!

If you're mixing or blending in big tanks, here's the newest way to slash mechanical mixer upkeep as much as 60%.

For here at last is a rotary mechanical seal—optional on new LIGHTNIN Side Entering Mixers—that stops leakage around the tank, ends stuffing-box repacking and adjusting for good.

And for the first time ever on big-tank mixers, you can replace this seal in a jiffy if you ever have to! No need to dismantle or remove the mixer from the tank. No need to drain the tank. No special skill required!

Even under a full head of liquid in the tank, the seal-change job is so simple it takes only minutes. The mixer shaft retracts to seal the tank, then uncouples. The seal cartridge slides off in one piece. A new cartridge slides on; the mixer shaft automatically realigns itself when recoupled—and you're back in operation.

The LIGHTNIN seal cartridge is a complete unit assembly, easy to stock as a replacement, or quickly obtainable in all sizes and materials, for the simplest or most difficult operating conditions.

Already, many oil companies are using LIGHTNIN Seals—and saving many thousands of dollars per year. Your LIGHTNIN Mixer representative can give you the full story—show you how much *you* can save. Call him today—he's listed in your copy of Refinery Catalog. Or get the facts by mail: send the coupon for 8-page, fully illustrated bulletin.

Lightnin® Mixers
MIXCO fluid mixing specialists

Left: **NO STUFFING BOX** to repack or adjust. No leakage around the tank. When correctly applied, seal runs for years without adjustment. *Right:* **REPLACEMENT** is simple, even with tank full. Mixer shutoff closes like a valve to keep liquid in the tank while seal is being changed.

☐ ***Quick!*** **Send us the cost-cutting facts on LIGHTNIN Rotary Mechanical Seals—Bulletin B-111. We'd also like catalog information on these LIGHTNIN Mixers:**

- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
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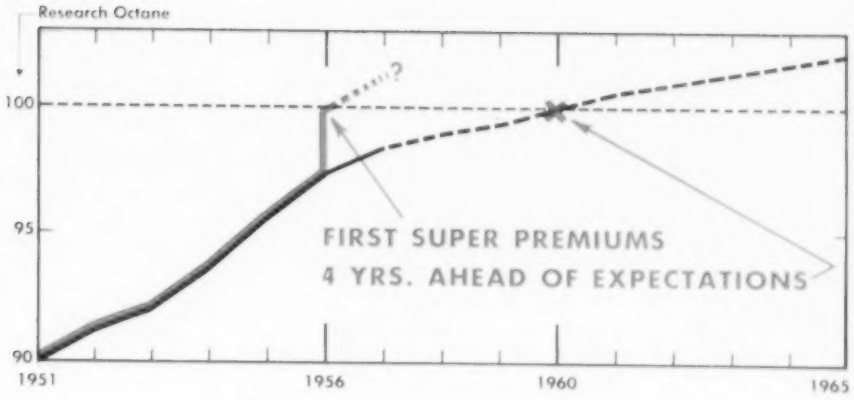
OCTOBER 1956



The Time Table Changed

With 100-octane hitting filling stations now, what new problems does the industry face?

By V. B. GUTHRIE
Associate Editor

THE REFINERS who brought 100-octane gasoline to the service stations this summer, were about four years ahead of schedule, as the chart above shows.

Up to now, estimates had been that premium grades would not average 100 octane until 1960.

This swift action presses economic and technological problems on all the nation's refiners earlier than anticipated.

Four major problems are:

1—Will the general trend be to market the new special grades separately from present premiums? Or, will refiners step up the present premium grades to whatever octane levels are required by the new model higher compression ratio cars?

2—What will be the effect of the new fuels on the regular grades now being manufactured and marketed?

3—How will the automotive industry react to increased availability of 100 octane and higher gasolines?

4—How will refiners produce the higher octane gasolines?

General Trends

By early last month, nine large oil companies had introduced a fuel in the 100 octane range—either by selling a special new super premium in addition to their established premium grade, or by replacing their established premium with an improved fuel. (See box on next page.) These new gasolines are being marketed principally in New England, along the Atlantic seaboard, in the South, and in Texas.

These companies have taken this route to providing a gasoline that will satisfy the highest compression ratio 1956 and 1957 model cars. Average ratio in the '56's is 8.45:1. Half the '57 model are expected to average 9.14:1, and by 1958 some 10:1 ratio models are expected.

No specific reference to octane numbers has been made in most of the public announcements of the new fuels. They have simply been described in such terms as: "the most powerful gasolines for the most powerful cars"—"designed specifically to meet the needs of the most critical cars"—"to overcome the problems that now limit more efficient engine design" and so on.

They are not being promoted as 100 octane or higher fuels for at least two reasons:

1—Many refiners today can make a gasoline in this range. Therefore, the octane listing loses its competitive advantage.

2—Premium gasolines of even higher antiknock rating may soon be required to keep up with further anticipated increases in compression ratios.

Those oil firms that have not yet announced a special new premium state that their established

Who's Doing What With 100-octane Fuels?

Selling a Super Premium Separately

Sun Oil Co. started selling 100-octane gasoline in the Orlando, Fla., area last February, introducing a new dispensing system that supplies five grades of gasoline from one pump, from regular to above 100 octane, with a suggested spread of 1¢ for each grade. Sales have since been extended throughout Florida and into southern Georgia.

Esso Standard Oil Co. announced a special high octane premium May 1, selling from a third pump, in addition to its present premium and regular grades. Special is priced 3¢ above premium. Sales being extended throughout its territory, New England, down the Atlantic coast to Georgia, and inland to Louisiana.

Humble Oil Co. in August announced the same three-grade system for its territory: Texas, and, in 1958, New Mexico.

Standard Oil Co. of Kentucky also in August, adopted the three-grade system in its territory, Kentucky, Florida, Alabama and Mississippi.

Cities Service Co. in September announced it will market a special premium, with an octane rating over 100, separately from its present premium, which will, however, be stepped up in octane value. The new fuel, selling 4¢ over regular, will be marketed initially in key areas on the Atlantic seaboard and in the South.

Continental Oil Co. is experimenting with a special premium, sold through a third pump, in Houston. Plans include expansion of marketing area.

Replacing Present Premium Gasolines

Shell Oil Co. July 31 announced its new super premium, in the 100-octane range, to replace its established premium and sell 1¢ higher. Initial distribution scheduled for Atlantic seaboard states.

Sinclair Oil Corp. starting Sept. 11, introduced its new high octane premium, treated with a new chemical additive, throughout its 37-state area. The new gasoline will replace present premium, sell 1¢ higher.

Richfield Oil Corp. of New York starting in September will introduce its new premium gasoline, with a "chemical power booster," in its territory extending from Maine to Florida along the Atlantic seacoast. It will replace present premium. This company is a subsidiary of Sinclair. It has no connection whatever with Richfield Oil Corp., Sinclair's affiliate in California.

grades will be improved to meet requirements the new cars will present.

One Premium or Two?

Of the nine companies selling or about ready to sell a new premium, six will make it an addition to their existing top grade and three are replacing present premiums with the new one.

Sun Oil Co. started the parade last February with its unique new service station pump on an experimental basis (see this month's cover picture). Then, in May, Esso Standard Oil Co. hit the market with a new "Golden Esso Extra" in a third pump.

Esso's "two-premium grade" program was dictated by the present accelerated rate of increase in compression ratios of the new model automobiles and the growing spread between octane requirement of the new cars and that of the average car on the road. Although compression ratios of new cars being sold advanced only 0.5 between 1940 and 1950, they increased a full point—from 7.5:1 to 8.5:1 during the past three years.

As a result, the *difference* in ratio between the average car on the road and the average *new* car hitting the road has moved from 0.5 in 1952 to 1.1 today and is expected to be 2.2 by 1961.

Furthermore, there is an even wider spread today between the *highest* compression ratio new model and the average car on the road—nearly 3 points. Translated into octanes (see chart), today's requirement for the average *new* car is 5 numbers above that for the average car on the road. And, by 1961 this spread is expected to be 7 numbers.

The 1961 spread is actually enhanced at the high end of the scale because each octane number is larger in terms of available performance.

"Unfortunately, at these higher levels," an Esso spokesman stated, "octane numbers are also a lot bigger in terms of cost. For example, to produce an additional octane number at the level required by the highest compression ratio 1956 cars is three times as costly as producing an additional octane number at the level required by the average 1956 car."

The soundest way to meet the economic conditions created for both the refiners and the automobile driving public by this growing spread in octane requirements, Esso believes, is in selling a special premium grade motor fuel through a third pump, yet retaining its existing premium and regular grades.

This procedure spares the refiner the cost of adding processing equipment necessary to raise the octane of all his premium grade. The motorist whose car requires the highest octane pays the additional cost of manufacture. The burden on the refiner is less where he improves the quality only of one top grade fuel.

Esso believes that it would cost the nation's refining industry $3-billion to install the equipment needed to produce the 1961 octane quality if *all* existing premium grades were continuously raised to stay on par with the highest compression ratio automobile engines.

In fact, the cost of making a special grade only for the most critical cars, Esso estimates at $1.6-billion. Increasing the unit gasoline price only for the motorist whose car can take

advantage of such higher octane quality would mean a nation-wide saving to the motoring public of $0.5-billion by 1961, the company believes.

This same basic principle—providing a special grade for those engines that require it—is also being followed by Sun Oil Co. in its Orlando, Fla., tryout program.

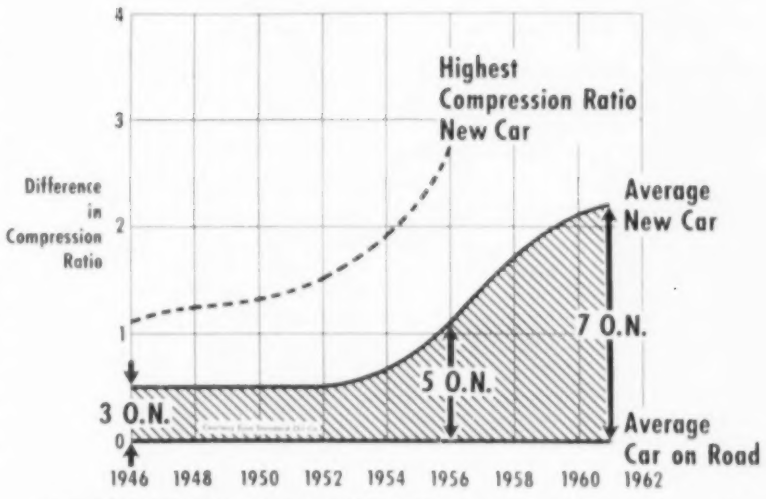
Sun's system differs from Esso's, however. It permits the motorist to select his own grade from five different grades dispensed through one service station pump. Octane rating is raised by increasing the proportion of an "octane concentrate" that is blended with the base gasoline. A difference of 1¢/gal between each grade has been suggested by the company. Esso's new third grade sells at 3¢/gal more than the previous top grade.

The most expedient way for refiners generally to supply gasoline for new model cars is to sell the special grade separately from the existing premium. In volume, this might account for 10-15% of their total gasoline supply. They could use as the base stock the cream of their pool gasoline. In a year or so, with 2.5 ml/gal of TEL, this will be a 93 octane Research, refinery engineers say. A special premium well over 100 can be obtained by blending this base with reformate, alkylate, or other high octane components.

However, conventional premium gasolines might suffer through the loss of the high octane portions and the use of large quantities of available reformate.

For some companies, marketing economics will be a larger factor in their decisions to continue to market only *one* grade of premium, raising its octane and other qualities as needed. Both Shell Oil and Sinclair, who have announced new "super" premiums as replacing present premiums, operate widely over the country. The cost of new pumps and tanks to handle an extra grade would run into many millions of dollars. The companies do not feel warranted in making such an investment, nor in asking their marketing distributors to make it for such a small proportion of car owners. They are satisfied they can step up the octane of their present fuels.

Both Shell and Sinclair play up the role of chemical additives in their fuels, which reduce engine deposits, preignition knock, and spark plug fouling, thus decreasing the actual octane requirement of cars on the road. This one-grade policy has also been stated by Standard Oil Co. (Indiana), Socony Mobil Oil Co., Inc., and Pure Oil Co., although these firms have not yet announced any new improved premium fuels.



HOW COMPRESSION RATIO TRENDS AFFECT octane number requirements

It now seems that the majority of the large refiners and gasoline marketers will continue to step up the octane of their premium gasolines to approach that of the new special premiums, yet sell for 2 to 3¢/gal less. As a result, some authorities question whether a special high octane premium at a third pump can survive the competition.

At least one automobile authority supports the "one-grade in the future" viewpoint. He feels the increases in compression ratios of low price cars will tend to lessen the range in octane needs of all new models, so that one premium gasoline will satisfy practically all new models.

"Significantly, all the low-priced, large volume cars now have optional engines or power kits that require premium fuels," said Victor G. Raviolo, Director of Car Engineering, Lincoln and Mercury, before the Atlanta chapter of the Society of Automotive Engineers. "Also, a number of medium priced cars have already introduced standard models with high octane fuel requirements. Today, where regular fuel costs 30¢, and premium, 32¢, this is not an impressive difference to the customer.

"As a result, this price penalty will not deter the automobile manufacturer from specifying premium fuel. There will be an inevitable pressure to close the gap between the low compression ratio, low priced cars and high compression ratio, high priced cars. This pressure will result in a narrower range of compression ratios and a single large-volume pool gasoline by 1960-1962. There may be some small demand for still higher octane gasolines, but this cannot be significant, or the regular (premium) market will absorb it completely."

Effects on Regular Grades

Up to now, little attention seems to have been given to what will happen to regular grade gasolines under the new situation.

Esso Standard said it would continue to improve the octane of its regular fuel "in keeping with the requirement increases that will take place in the overall car population."

One oil company automotive engineer believes that maintaining engine cleanliness with the additives now available will be more important than a step up in octane, because of the great range in age, engine condition, and driver habits of older cars on the road.

When Cities Service introduced its special new premium, it also said its regular grade was "being enriched with protective aviation ingredients to improve performance characteristics."

The rate of increase in Research octane for regular grades is not as great as that for premium grades. This year the average octane for premium (not including the new specials) is 98 Research. The average for regular is estimated at 90. The 8-point spread is larger than ever before and this spread is expected to continue.

Nothing But Higher Compression Ratios Ahead

Both oil and automotive industry engineers agree that compression ratios

of the new cars will continue to climb at the present accelerated rate.

Here's the Detroit slant.

"There is no doubt that by 1957-58, there will be a large volume production of cars with compression ratios of 10:1 or higher, with a requirement for a fuel of 100 Research octane numbers," Lincoln-Mercury's Raviolo said. "Of course, this means we need a lot of 100-octane fuel then, and we will probably get it.

"I feel certain that ultimate compression ratios will be increased beyond 10:1, to 11.5:1 or possibly 12:1. That means we will have to find methods to produce gasoline that will rate over 100 octane."

What oilmen think:

If the present trend in ratios is extrapolated, ratios in the neighborhood of 11:1 may be predicted for 1960, R. D. Young, Motor Fuels Section Leader, Sinclair Research Laboratories, Inc., said when the new Sinclair premium gasoline was announced: "The increased combustion chamber pressures and temperatures accompanying the rise in compression ratios will necessitate the use of still higher octane number fuels.

"These will not only be more costly to manufacture, but a problem of supply may develop as a larger percentage of the automobile population shifts to higher compression ratio engines. Therefore, any way to reduce the stabilized octane requirement of an engine warrants the fullest consideration."

Looking farther ahead, Esso Standard believes the emphasis on higher and higher compression ratios may ease off before 1965. They reason that a point may be reached where the economics will not favor raising compression ratios and making the high octane necessary to fuel them. Esso thinks this may happen at around the 12:1 ratio, which may be reached by 1962 or 1963.

How Will Refiners Make The New Premium Fuels?

Catalytic reforming is still considered the most economical route to higher octanes. With over 950,000 b/d capacity installed in almost half the U. S. refineries, this process at present makes up to 10-15% of the motor fuel supply, and this volume will be greatly increased in the future.

Gasoline made by cat reforming is highly aromatic. Therefore, it has high antiknock value. Undesirable characteristics are its high sensitivity (difference between Research and Motor octane) and its susceptibility to surface ignition.

Blending reformate with straight-run gasoline and other components can economically boost. Research octanes by 7 or 8 numbers. Refiners believe that 103 Research is a practical economic level for fuel using reformate. Higher octane reformate can be made, depending upon the composition of the naphtha feed, but more severe operating conditions are required. This cuts into yields and raises unit costs. The cost of building more octanes in the range of 100 by using reformate is estimated at 0.75-1¢/gal.

Another method available currently to a limited extent is to raise the octane of premium fuel with alkylate. U. S. charge capacity of alkylation units is 250,000 b/d. However, a considerable portion of this material is required for aviation gasoline. Hence supplies for automobile fuel are limited.

A later step that refiners may adopt is isomerization. This process converts normal pentane and hexane fractions of refinery naphtha and natural gasoline into higher octane isomers that can be used for motor fuel blends. To produce "isomate" commercially, refiners must virtually start from scratch. Four small isomerization plants were operated during World War II. One used Shell Oil's liquid-phase process for the conversion of normal butane and normal pentane into blending material for aviation gasoline, and the three others employed the Indiana Standard process using hexane and hexane-pentane fractions for feed stocks.

Today's total isomerization capacity is only about 10,000 b/d. However, considerable renewed interest is being shown in the process. In addition to the two commercial processes in use, Universal Oil Products Co., Pure Oil Co., and Atlantic Refining Co. have all announced new isomerization processes. Still others are in the research stage. (For more details on Atlantic's "Pentafining" process see this month's Process Data Sheet, pp. 101-103.)

Motor fuel sensitivity will demand more attention from refiners as an index of road antiknock performance. This is because of the growing use of catalytic reformate—which has high sensitivity—and the greater number of new cars coming out with automatic transmissions.

Why is this true? Until recent years, the improvement in antiknock performance cracked gasolines provided over straight-run gasoline was actually better than indicated by the earlier, F-2 (Motor) method for rating octane values.

To overcome this deficiency in measuring, the F-1 (Research) method was adopted. Today's specifications for most commercial gasolines are based on Research method only. And Research continued to be a good index before the adoption of automatic transmissions, when relatively low engine speeds were still the requirement for full throttle operation of the vehicle.

However, there is now a reverse trend away from Research method alone for measuring road antiknock performance. With automatic transmissions, even in normal city driving, the engine often reaches speeds in excess of 4000 rpm. For these conditions the Motor method is regarded as a better index than Research method.

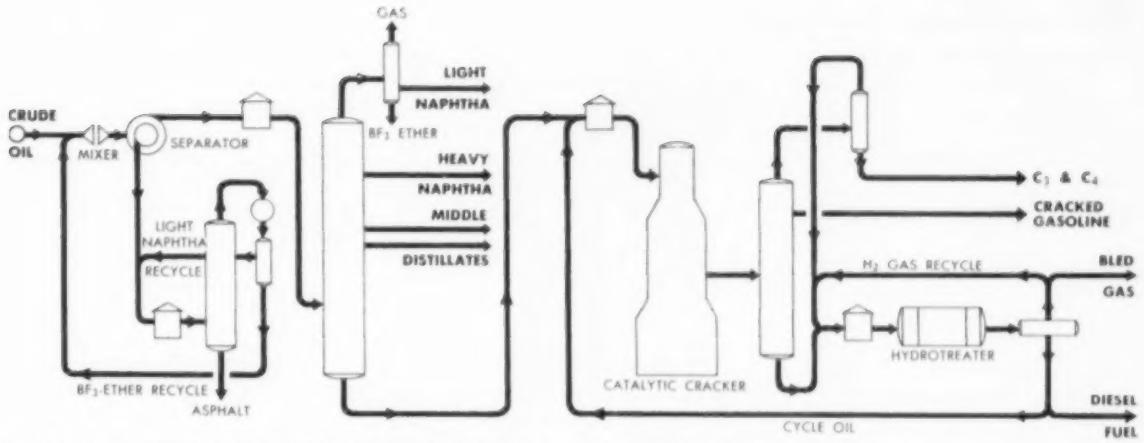
Fuel sensitivity becomes even more important as the trend continues toward automatic transmissions of the torque converter type. These engines *prevent* engine loading at low engine speeds. This, in turn, shifts the maximum requirement for octanes from low to high speeds.

The refiner who uses more catalytic reformate in his premium gasoline will have to find other components to keep the sensitivity of his finished gasoline within the desired limits.

THIS MONTH'S COVER

. . . shows the unique new service station pump Sun Oil Co. introduced experimentally in a number of Orlando, Fla., outlets last February, to start off the 1956 parade of 100-octane suppliers.

The pump contains a blending mechanism that permits the customer to choose the particular grade of gasoline he wants to buy. The operator sets the dials and the pump fills his automobile tank with the specified grade. The mechanism automatically proportions a specific amount of "octane concentrate" into a base gasoline. The customer pays—under Sun's experimental arrangement—1¢/gal more for each higher grade of fuel. Photo was furnished through the courtesy of Sun Oil Co.



HOW THE NEW FEED PREPARATION PROCESS FITS into a general refining flow

Feed Preparation a Problem?

Boron fluoride-ether complex is used to increase yield of cracking charge stock

A UNIQUE new feed preparation process for catalytic cracking charge stock is being advanced as an economic approach to the problem of increasing gasoline yield from crude.

It is essentially a treatment of the crude oil with a boron trifluoride ethyl-ether complex, which separates and removes as much of the coke-forming and metallic constituents as possible while minimizing loss of useful heavy ends. Not yet in commercial operation, it is covered by U. S. Patent No. 2,745,792, issued May 15, 1956 to C. D. Shiah, director of the Chinese Government Procurement & Services Mission, a division of Chinese Petroleum Corp., New York. A technical paper announcing and describing the process was presented by Mr. Shiah at the Casper, Wyo., meeting of the Western Petroleum Refiner's Assn. late last month.

In a typical example cited by Mr. Shiah, a 31.8° API Kuwait crude oil is mixed with 2.5 vol-% of the BF_3-Ether, and the mixture is centrifuged. The BF-Ether is recovered by partial pressure distillation. Treated crude is fractionated, and the reduced treated crude is catalytically cracked with natural catalyst, using a catalyst make-up rate twice as high as normal.

Gross dollar returns are increased about 20%, Mr. Shiah said. In addition, the process makes sufficient hydrogen available to saturate all the olefins in the cracked products.

The process can also be used in treating other stocks, such as heavy recycle oil, No. 2 fuel oil, and catalytic reformer feed.

Mr. Shiah argues that the traditional concept that cracking unit feed must be completely free of metallic constituents and coke-forming materials is neither technically necessary nor economically sound. He feels his process comes close to the ideal solution, removal of these materials with a minimum sacrifice of useful oils.

What is BF-Ether?

The reagent used in this new feed preparation process is boron trifluoride—ethyl ether complex; BF_3-$C_2H_5OC_2H_5$. Its properties are: melting point, —60.4° C.; boiling point, 125.7°C.; density, 1.125 at 25°C.; refractive index, 1.348. It is non-toxic and non-corrosive in the absence of water (water causes some decomposition to HF). It is insoluble in paraffins and cycloparaffins; completely miscible in aromatics. It provides no additional fire hazard to that normal with petroleum hydrocarbons.

It is currently being manufactured by Harshaw Chemical Co. and General Chemical Div., Allied Chemical & Dye Corp., and is in limited use as a catalyst. Today's price is 35¢/lb.

As shown in the flow diagram, crude oil is first mixed intimately with BF_3-Ether (2.5 vol%) at normal temperature and pressure, preferably under an inert gas blanket to avoid evaporation losses. Separation is accomplished by centrifuging or settling.

The "tar" with the bulk of the reagent separates as the heavier material, and is diluted with a light naptha stream, heated and distilled. All the BF-Ether in the system will be carried over by the light naptha and condensed as a lower layer covered by a light naphtha layer. The naphtha is recycled and the reagent is re-used.

The bulk of the oil containing traces of the reagent is fractionated. Traces of the compound are carried over by light naphtha and separated out as a lower layer on condensation.

Reaction of the BF_3-Ether with sulfur compounds is non-selective. Therefore, it acts equally well on mercaptans and cyclic sulfur compounds. By treating the whole instead of the reduced crude, the process reduces sulfur content of the lighter fractions simultaneously.

In the final step, the topped crude is charged direct to the cracking unit. The cycle oil is hydrofined by the hydrogen-rich cracking gases, all or a part of which can be recycled and the balance sold as high quality distillate product. The heavy straight run naphtha can be catalytically reformed

Table 1—Typical Yield Data and Characteristics of Cracking Unit Feed Stock

(Basis—100 bbl of 31.8° API Kuwait Crude)

Product	Boiling range, °F	Yield wt-%	Yield vol-%	Yield bbl
Str. run lt. naphtha	IBP-200	8.6	11.3	11.3
Str. run heavy naph.	200-380	12.4	14.8	14.8
Lt. diesel fuel	380-560	15	15.5	15.5
Cracking charge stock	560-up	54	50.5	50.5
Asphaltenes	—	10	8	(3030 lb.)
Characteristics of the catalytic unit feed:				
Gravity, ° API				21.3
Con. carbon, wt-%				5.86
Sulfur, wt-%				3.68
Vanadium, ppm				15.6
Nickel, ppm				6.7

Table 2—Cracking Unit Yields

(Based on 50.5 bbl of feed—see Table 1)

Product	Total	
Hydrogen	19,700 cu ft.	390 cu ft/bbl
Gases	6,550 cu ft	130 cu ft/bbl
C_3 and C_4 olefins	3.68 bbl.	7.3 vol-%
Gasoline, C_5-400°F EP	18.4 bbl	36.3 vol-%
Cycle oil	25.3 bbl	50 vol-%
Coke	2030 lb.	12.4 wt-%

by any known conventional methods.

What is the economic advantage for the new process? Gross dollar returns can be boosted almost 20%, according to Mr. Shiah.

Typical yield data for the feed preparation unit flow just described are given in Table 1 for 100 bbl of 31.8° API Kuwait crude, along with the characteristics of the cracking unit feed stock. The total metals content in this stock is 22.3 ppm. At a catalyst makeup rate of 1.5 lb/bbl, this equals an equilibrium metal concentration on the catalyst of 4910 ppm. Catalytic cracking of this stock at 50% conversion, using a natural catalyst with 4910 ppm metals content, gives a yield shown in Table 2.

Mr. Shiah then combines the light and heavy naphtha and the C_5-400 EP cat-cracked gasoline for total raw gasoline, and considers the yield of finished gasoline to be 95% of the raw. He also assumes there is enough isobutane in the gas to alkylate all the olefins and that the yield of alkylate is 160% of the olefins.

Total gasoline yield from the original 100 bbl of Kuwait crude in the example is, therefore, 48.5 bbl.

It can be further assumed that all the cycle oil can be hydrofined into light and medium diesel fuels because there is about 777 cu ft of H_2 available for every bbl of cycle oil (19,700/25.3). Total diesel fuel yield, therefore is 15.5+25.3=40.8 bbl. Asphalt yield as shown in Table 1 is 3030 lb.

What are the results without the BF-Ether treatment?

In the first place, the 560°F. and up portion of the crude would have to be vacuum flashed or propane deasphalted to obtain a heavy gas oil charge stock for the catalytic cracker.

Vacuum flashing reduces the 50.5 bbl of the 560°F and up fraction to 17 bbl of asphaltic residue and 33.5 bbl of gas oil. Catalytic cracking of this gas oil at 50% conversion, using the same type catalyst, gives:

Products	Percent		Bbl
C_3 and lighter	3.1	wt-%	—
C_3	3.78	vol-%	1.27
C_4	5.5	vol-%	1.85
C_5-450°F	38	vol-%	12.8
Lt gas oil	20.8	vol-%	7
Hvy gas oil	29.0	vol-%	9.7
Carbon	3.9	vol-%	—

In this example, the total gasoline yield would be 41.87 bbl (95% of total raw gasoline plus 160% of total olefins).

Total diesel fuel would be 15.5+7 or 22.5 bbl, assuming there is enough surplus hydrogen available from a catalytic reformer to refine the light cycle oil into a saleable diesel fuel. The vacuum tar and the heavy cycle oil would have to be disposed of as No. 6 bunker fuel: the total would be 17+9.7 or 26.7 bbl.

A comparison of gross returns for the two cases, shown in Table 3, indicates a 19.2% differential favoring the new process.

A further alternate, not shown in the flow diagram, can be taken because of the plentiful supply of hydrogen. All the olefins in the cat-cracked gasoline can be saturated and all the cycle oils can be hydro-refined. The olefin-free cat-cracked gasoline can be further improved by catalytic reforming either before or after aromatic separa-

Table 3—Gross Returns Higher for New Process

(Basis—100 bbl of Kuwait Crude)

Products	$/bbl	Conventional bbl	Conventional $	New Process bbl	New Process $
Gasoline	5.25	41.9	220	48.5	255
Diesel fuels	3.80	22.5	85.5	40.8	155
No. 6 fuel oil	2.10	26.7	56	0	0
Asphalt	(0.0068/lb.)	0	0	(3030 lb)	20.6
Totals			$361.5		$430.6

Table 4—How Five Different Crude Oils Are Affected by the Boron Fluoride-Ether Reagent

(Based on 2.5% reagent, except on Wafra crude, which was 4%)

Properties	Kuwait Before	Kuwait After	Wafra Before	Wafra After	East Texas sweet Before	East Texas reduced After	West Texas 48% reduced Before	West Texas 48% reduced After	Texas Heavy sour reduced Before	Texas Heavy sour reduced After
Yield vol-%	100	92	100	90	100	97	100	98	100	91
Gravity, ° API	31.4	32	24.3	30	21.2	23.7	18.2	19	16.6	21.7
Con. carbon, wt-%	5.0	3.55	7.43	5.35	4.19	2.52	6.3	5.2	9.66	4.38
Sulfur, wt-%	2.65	2.27	3.11	2.17	0.99	0.82	2.97	2.94	2.42	2.33
Nickel, ppm	8	4.3	16.7	7.5	—	—	10.2	4.7	—	—
Vanadium, ppm	22	10	65	30	—	—	15.3	9.2	—	—
Salt, lb/1000 bbl	—	—	20.1	0	108	2.4	—	—	55.6	13.6
Ash, wt-%	—	—	0.015	nil	0.03	nil	—	—	—	—
Nitrogen, wt-%	—	—	0.162	0.113	—	—	—	—	—	—

tion. The hydro-refined cycle oil can either be recycled through the cracking unit or sold as a finished product.

Investment and Operating Costs

No detailed data have as yet been developed to permit accurate evaluation of costs for the new process. Mr. Shiah stated, however, that both initial and operating costs would be comparable if not lower than ordinary vacuum flashing. He pointed out that the BF-Ether treatment would take the place of existing feed preparation methods such as vacuum flashing and/or solvent extraction. It takes place at normal temperature and pressure and the reagent is non-corrosive in the absence of moisture.

The reagent itself, though now available commercially, is still quite highly priced—35¢/lb. However, it can be made from inexpensive material (borax, calcium fluoride, and sulfuric acid), hence, there is no reason why the price should not drop with large demand. One manufacturer has indicated the price could go down to a 15-20¢/lb level.

An important factor is in the recovery and re-use of the reagent. Mr. Shiah has obtained over 99% recovery consistently in the laboratory, and feels efficient plant design could improve even this recovery figure. At a 1% loss level and using the current price of 35¢/lb, the chemical cost per bbl of oil is about 2.75¢.

Why the Process Was Developed

The most realistic goal for a cat cracker feed preparation process as visualized by Mr. Shiah and his associates was—as explained previously—to remove as much of the coke-formers and metals from the crude as possible with a minimum sacrifice of useful oil.

They defined coke-formers as the constituents in the oil that will yield more than 50% of coke upon catalytic cracking. For example, a 50% reduced West Texas crude with a Conradson carbon of 6.3% might be considered as containing about 12.6% of coke-formers.

In Fig. 1, starting from the bottom of the crude, the first portion of bottoms removed contains undoubtedly mostly coke-formers with very little useful oil. As the amount of bottoms removed becomes progressively greater (from right to left), the amount of useful oil taken along with the coke-formers also grows (left-hand vertical scale, reading downward).

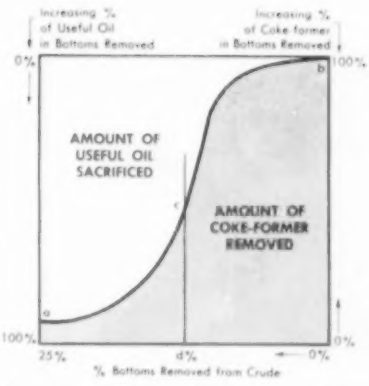


Fig. 1—**EFFECTS OF** coke-former removal from residuum oil

Somewhere along this curve *abc*, a point of inflection, *c*, is reached. Thereafter, any incremental amount of coke-former removed will drag along with it an amount of useful oil greater than the coke-former itself.

Therefore, the optimum amount of bottoms to be removed from the residuum oil would be *d*% of the crude. Roughly speaking, *d* would equal the percent of asphaltenes in the oil. For ordinary crude of 30-40° API, *d* is usually less than 10%.

Following this reasoning, the aim was for an economical and simple process that could remove less than 10% bottoms from an ordinary crude oil. Mr. Shiah said that to achieve this by vacuum distillation would be impractical in most situations. Propane or solvent extraction would require large solvent-to-oil ratio and pressure operation and, therefore, would be expensive.

How the Process Works

The basic principle of the new technique was described by Mr. Shiah:

"It is generally agreed that the asphaltenes exist in the oil in a colloidal state and the resins act as protective colloids. * if some way could be found to disrupt this colloidal equilibrium, it is conceivable that the asphaltenes would coalesce and separate out from the system. This I found is exactly what happens when a crude oil or residual oil is treated with a minute amount of boron fluoride ethyl ether coordination compound. Literally, a drop of this material in a bucket of residuum oil would immediately cause the asphaltenes to coalesce and separate as a lower layer. No heat or pressure is required . . ."

Some typical results of treating several types of crude oils with the reagent are shown in Table 4. These are indicative only and do not represent the best results obtainable under optimum operating conditions.

A comparison between treated reduced crude, or treated crude, after topping off light straight run product, with a vacuum gas oil or a propane treated oil, shows equal results except for higher carbon and metals content with the treated oils.

This kind of stock—reduced crude treated with the reagent—can be charged directly to the cat cracker, Mr. Shiah contends. Though it still contains considerable quantities of coke-formers, nearly all the coke-formers that could be removed without sacrifice of useful oil have been removed. Therefore, the larger regenerator capacity required to burn off the extra carbon becomes economically justified.

How Much Metals Is Too Much?

The metals content is high but may not be intolerable. Mr. Shiah pointed out that nobody has as yet been able to ascertain the maximum tolerable limit of metals on catalyst. He argued that the general practice is to play safe and specify a feed stock almost completely free of metals.

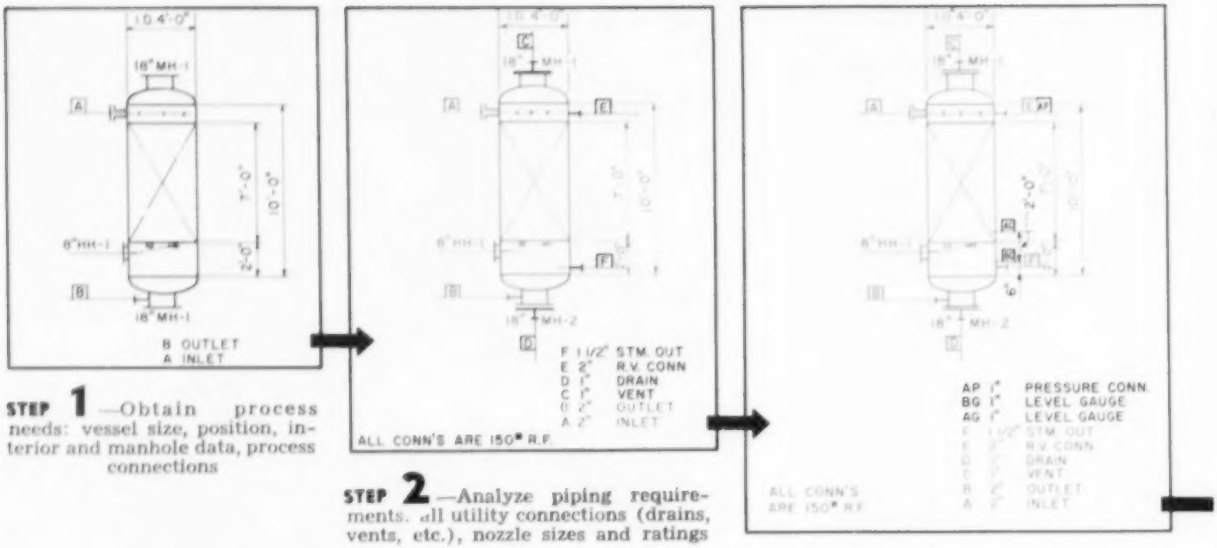
He then developed figures to show the effect of raising the equilibrium metals concentration on the catalyst from 0 to 3310 ppm. There is about a 2% increase in carbon yield, 2% decrease in gasoline yield, and it increases hydrogen yield from 50 to 275 cu ft/bbl of feed.

The result is the equivalent of converting two bbl of raw cracked gasoline into 32,500 cu ft of hydrogen. If the raw gasoline is assumed to be worth $5/bbl, then the cost of the hydrogen produced from it is $5 \times 2/32{,}500 \times 1000 = 30.8¢/1000$ cu ft.

Thus, Mr. Shiah states, "We are producing more gasoline plus this extra hydrogen as a by-product. Also, because of the higher hydrogen yield, it is likely that the gasoline product is more aromatic and more olefinic than ordinary cat-cracked gasoline and, therefore, has a higher octane rating. It is, consequently, superfluous to assign any cost to the extra hydrogen produced."

No process licensing arrangement plans nor plant construction plans have as yet been announced for the new process.

* Kalichevsky, V.A. "Modern Methods of Refining Lubricating Oils." pp. 80-85, Reinhold Publishing Co., New York (1938).



STEP 1—Obtain process needs: vessel size, position, interior and manhole data, process connections

STEP 2—Analyze piping requirements. all utility connections (drains, vents, etc.), nozzle sizes and ratings

STEP 3—Add instrument connections: obtain data from process control diagrams and instrument data sketches

Here's How a Vessel is Assembly-Line-Designed Co-ordinating these Design Procedures Will . . .

Boost Your Drafting Production

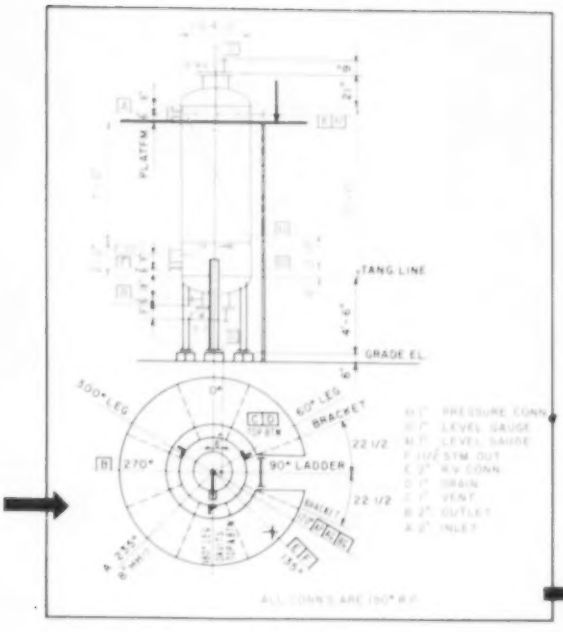
By ROBERT KERN, London, Great Britain

This last in the series of articles on drafting production stresses the importance of co-ordinating overall design. Without this, the factors discussed in previous articles—physical efficiency, mental efficiency, and methods of presentaton—cannot contribute their maximum to efficient production of engineering drawings.

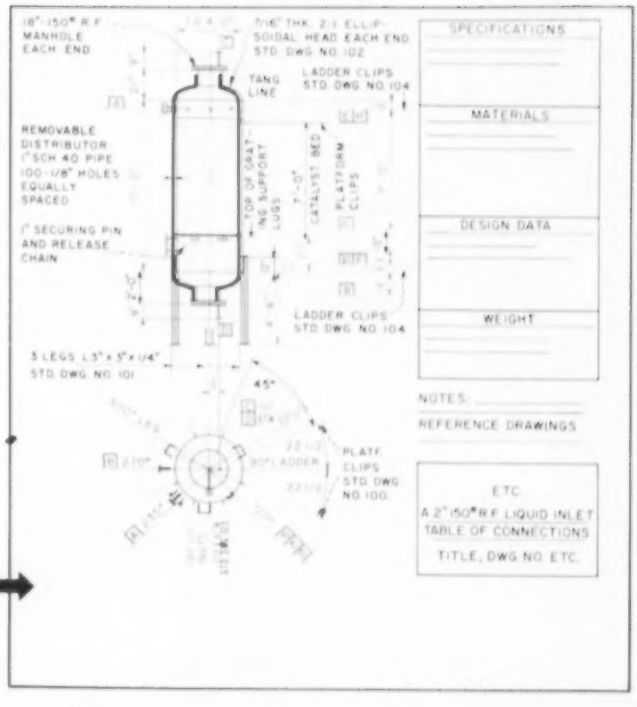
The author stresses the importance of the organization of the design office and suggests several ways of doing this to ensure maximum efficiency.

THE SAME PRINCIPLES that have proved successful in mass-producing automobiles—organizing the operator's output by constant study and research, simplifying manufacturing methods, assembly operations and knowledge of the product itself—can also be applied to the production of engineering drawings. The above illustration shows the normal steps in the "assembly line" production of a finished design drawing. The blank sheet of paper that enters the production line goes through many operations until it leaves as the final and finished drawing, ready for the fabricator and field construction team. These production operations, which are listed above, fall into two general classifications: design development and physical location of the developed information.

Assembly line design of a vessel is



STEP 4—Physically locate these items: nozzle connections, vessel elevation, supported platforms, supporting steel, equipment orientation



STEP 5—Design the vessel: code requirements, stress calculations, material thicknesses, and make the detailed assembly drawing for the construction later work

most effective when each operation is done in the shortest time possible and the time lag between each handling is cut to the minimum. Simplification permits speed, as do those mechanized work methods and drawing presentation techniques in previous articles. But the key to efficient production of an entire project is the overall coordination of drawing and design work, the subject of this last article. Only by successful overall coordination is it possible to receive maximum benefits from the other parts of drawing production discussed—physical efficiency, mental efficiency and drawing presentation.

The design of industrial plants is a collective effort and depends upon efficient dovetailing of the work of many people. An individual designer normally produces only a portion of a plant, but even there, design coordination is required for good design. It's the coordination of the individuals within a section plus the coordination between all design sections that spells the success of any project. Constant (and efficient) drawing production speed will depend then on the successful coordination of design engineering decisions, the right sequence of work, establishing production cycles and meeting scheduled dates.

Cooperation of Individuals

A designer who has specialized in one field of plant design is often confronted with problems that require consultation with men in other fields of plant design. How wide the scope of consultation, and how often these consultations are made will usually depend on the designer himself. But discussion of any problem requires the time of at least two or more designers. To be effective, the consultations will be short, well conducted and cover the entire problem; this requires some preparation before the conference. A consultant often, unless curbed, shows his capabilities for design detail too extensively. When, for instance, a decision is required only to choose from a number of possible solutions he must not be permitted to deviate from the main question and explore unnecessary details. Both the time and mental capacity of all participants can be wasted by too much consultation.

Usually a designer can get a better overall picture if several questions are discussed consecutively during a consultation. It's advisable to jot down all the problems occurring over a period of time, say a few days or weeks depending on the design, and then discuss them all at once. During the development of design some problems can alter or even disappear. Thus, it is wise to keep track of all related problems that can be discussed together to avoid missing an essential one that may require another conference.

There is yet another type of coordination required when an individual designer's plant area has to be integrated with the surrounding area, and the overall project. Structures, pipe lines, dimensions and locations must be matched and notes must be given that do not contradict those appearing on the drawings of other areas. Rather than a series of individualized layouts, the finished overall layout should reflect a master plan.

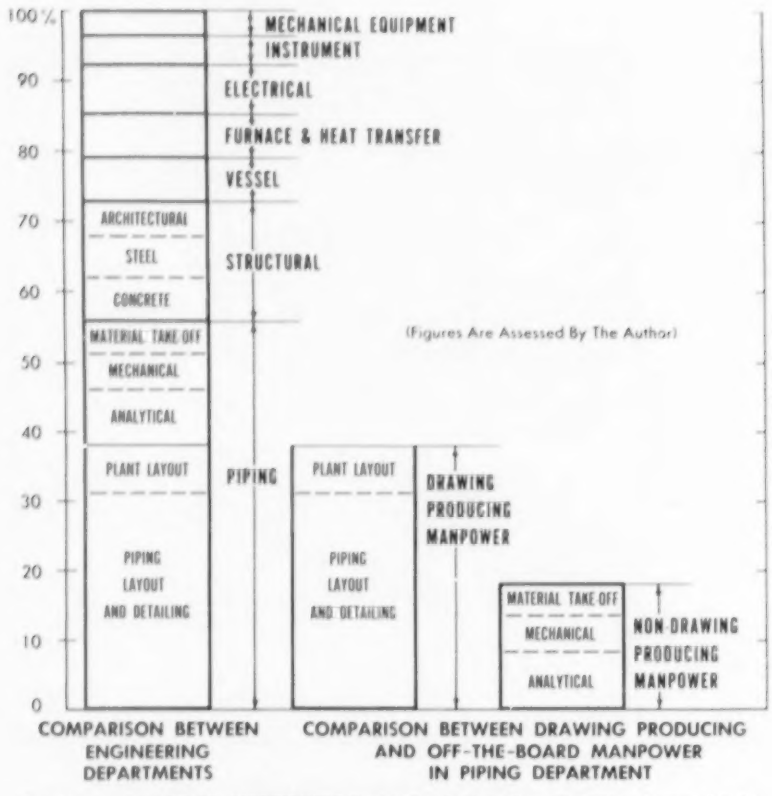


Fig. 20—**MANPOWER DISTRIBUTION** among design departments shows the importance of piping design.

This requires an interchange of ideas and decisions that harmonize the overall design. If the drawing work does not advance on common and agreed ground there will be a great deal of work wasted in checking, revising and redrawing.

The more involved a design is, the more will be the consultation required. Very few outside explanations may be needed for detail drawings but for initial plant design, frequent and varying advice is required. It's often advisable to have permanent advisors assigned to a large job—or to several jobs. Some companies go even a step further and have initial plant design executed by a group of experts, where (beside a wide field of engineering) the amount of work is a small proportion of the total work required for producing all necessary drawings. Under this procedure, the experts (the planning group) are constantly in touch with each other and can reach basic design decisions quickly. Using the normal method, in which the design is parceled out and there are series of secluded conversations between the few experts involved, it may stretch the work for solving basic questions far too long. These late decisions can then make drawings useless that are already finished.

Assembly Line Drawing Office

The production of drawings may often involve several successive assembly lines in an engineering organization. Individual designers and draftsmen are usually grouped in the interest of executing a job of wide scope but specific task. How such a group or section is composed to take advantage of the skill of its individuals depends on its activities.

A plant layout section has individuals with varied experience in the field of plant design and, as a whole, will cover a wide field of design engineering requirements. A piping detail section on the other hand is composed of men with similar experience but in a much narrower field of plant design. These sections connected with the major parts of design engineering form departments or divisions, but it is also necessary to have designers in the various fields of engineering who can cover the whole range of a company's activities.

The availability of sufficiently skilled personnel in a section or department is necessary for efficient drawing production. The best number will depend on the permanent work load in the organization. But the closer the relationship between the work load and the available manpower, the more efficient will be the production. An example of this numerical relationship between design sections is given in Figure 20.

Shown in Figure 20 are the relative proportions of the types of manpower in a typical engineering organization in oil refinery and chemical plant design. The total of 100% includes both those who work on the drawing boards and those who do not but are closely connected with drawing production. This latter group is composed of those engaged in analytical piping work (line sizing, pressure drop calculations, flow systems, valving, etc.); mechanical piping work (stress calculations and pipe support); and heat transfer calculations. Although this highly skilled and expensive work is intimately related to drawing production it is not itself productive.

Ratio Is Important

The significance of this division in organization lies in the proportion of "engineering" manpower to drawing producing manpower. If less brainpower can support a larger drafting organization the result will be more economical and efficient drawing production.

Today this is more easily obtained, because the days when beautiful and lengthy engineering calculations were made and understood by only a sacred few are gone. Simple, sound, and fast decisions and calculations must be made, especially when problems of design are so frequently repeated. Most calculations in chemical plant design are identical in concept. Standard calculation sheets, specialized charts, slide rules and other mechanical aids have now mechanized much of the individual engineer's work. This uniformity has improved design efficiency because it: (a) speeds up and provides more reliable results, (b) mechanizes some of the engineering process, (c) provides easy understanding of the work of other designers, (d) lends itself to effective control, and (e) avoids arguments about design decisions.

How To Organize Design Work

Design offices can be organized in several ways. It's often possible to find a drawing office that works in a constant maze of questions, communica-

tions, changing decisions, alterations and frequent omissions between departments even though individual designers may make attempts at organized plant design. It's possible to find, in this kind of office, by following a jig-saw of information flow and design development, a long route of successive design development. But this type of organization suffers many delays and much waste in the production of engineering drawings.

Even in such an office, if the amount of communication between design departments and between individuals is screened to a minimum, and communications are made short and direct, drawing production can be increased. Basic decisions can be made at the very beginning of a plant design and revisions held down. Work can then progress virtually undisturbed by influences from other departments and individuals. But, to obtain maximum efficiency in the production of the final drawings, the overall design office must be set up to permit independent and parallel production of drawings in all departments that contribute to the final design of an industrial plant. This can only be accomplished by separating the work of initiating a design from that of executing a design.

To accomplish this separation of design requires grouping competent designers in one section to only those drawings that provide basic information. This information then is supplied to all design departments so they may work on it simultaneously and independently.

Picking Designers

The group of designers selected for this initial planning group should come from the major fields of refinery and chemical plant design engineering and should have a wide professional experience. Their collective efforts will then establish a unified and responsible engineering philosophy. Each plant design will become characteristically well planned and designed instead of reflecting individual tastes, convictions and often mistaken design ideas. Such a group will be capable of preparing plans that embody a company's best experience, making design decisions at an early stage of design when alterations are not expensive, and turning out initial drawings that permit a simultaneous start and parallel work in the detail design.

This planning group's work is virtually finished when production design starts, except for one function. All changes, alterations, and revisions to basic information required for detail design are routed through this planning group. These changes are expertly investigated, screened, rejected or accepted and finally transmitted to all interested parties doing the detail design. Control of revisions by this planning group eliminates unnecessary conflict and confusion between engineering departments during detailing.

Controlling Communications

Even in a well organized design office, interdepartmental communications cannot be eliminated. But the control of essential correspondence and other written or verbal information can help drawing production.

A letter or technical report writer in an organization should remember that the time of many individuals is involved in reading and evaluating his material. Consequently, he himself should aim at economy in words and clarity in thoughts. Also, any one reading a report should evaluate and interpret it and pass it further only when the information is necessary for someone else.

Designers themselves must often ask questions that affect their own as well as other's work and time. If these questions are careless or unorganized they may frequently cause misunderstandings which only stimulate a fresh flow of inquiries. This type of uncontrolled information is graphically illustrated in Figure 21.

By checking on the volume of information at some strategic point within a department, the flow in and out can be reduced—as graphically illustrated in Figure 21. Only those requests that are essential should leave the departments or sections. And only those who are concerned should be informed of the final result. By strategic control of the flow of information the volume of requests can be reduced and the quality of questioning improved. The development of simple, short and concise letter writing will save much design time and eliminate misunderstandings.

Harmonious relations between sections and departments can also reduce the volume of communication, especially by the anticipation of required information. Individuals or sections responsible for issuing necessary information can forestall a lot of correspondence by issuing the information before it is requested. Voluntary transmittal of needed information will provide results without much effort, while failure to distribute expected information will generate unwanted correspondence. Critical information should not be stored on a designer's desk or board because someone may need it urgently. A speedy interdepartmental mailing system can hurry it (and regular mail) on to those who will need the information.

Design Sequence Is Important

In a sense, sections and departments of an engineering organization are the production lines that assemble a design with their available information. Without certain essential data the production line, or part of it, may become idle. Much data must be worked out by the section itself and used for further design development. This means that establishing a sequence of information and design steps will prevent gaps in production and enhance the smooth flow of the final product.

Practically every step in design depends on some preceding step. For instance, foundation design is difficult to execute without accurate soil data or load conditions. But the loading of structural steel footings depends on information supplied by the structural steel section, which awaits information on the weights and dimensions of the supported equipment. The weights of equipment, in turn, depend on equipment sizes, which depend on process conditions . . . and so on. The frustrating thing is that it is the end product in this information chain that must often be supplied to the field workers first. Thus, it is extremely important that the sequence of information is well established and adhered to.

Although it is impossible to define in detail the proper sequence of operations after a job enters a drawing office, the following is a general outline for oil refinery and chemical plant design.

Plot Plan Needs

A new contract enters the drawing office in the form of process flow sheets and specifications. These must be interpreted and turned into a physical plant. The first step is to develop a plot plan in connection with arrangement layouts. This requires the following:

1. Site map—which shows adjoining facilities to the plant site (roads, railroads, waterways, existing structures, process units, pipe banks, power lines, water supply).
2. Contour map and soil conditions —which are required to establish an economical grade ele-

■ Increase Drafting Production

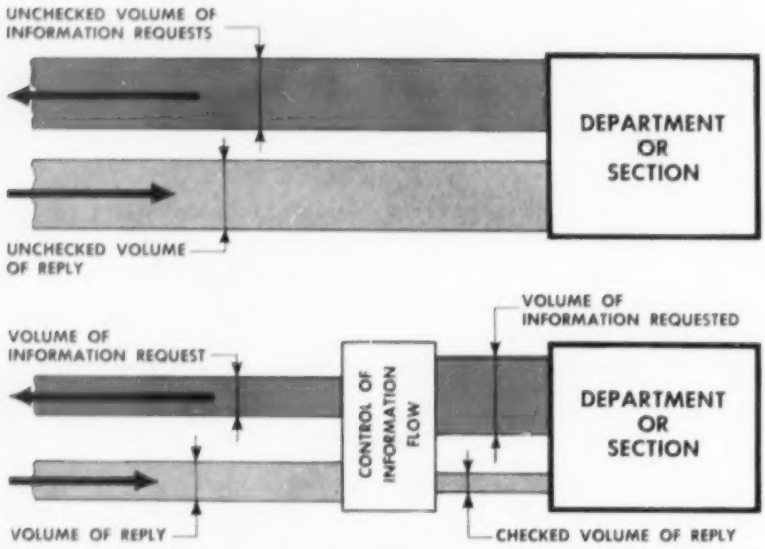


Fig. 21—**CONTROL OF COMMUNICATIONS** at strategic points will reduce the flow of unnecessary information, and improve design efficiency.

vation, to choose the type of foundation, and to make decisions on underground pipe and trench requirements.

3. Weather conditions—such as prevailing wind, rainfall, and seasonal temperature variations that will influence layout.
4. A reference point—to properly orient all drawings and design information both inside and outside the plant site.

Very often facilities that surround a plant will determine the location of access roads, pipe runs and building locations. Groups of equipment can then be arranged and relationships between these groups established.

Up to this point detail dimensions are not worked out. Meanwhile the overall arrangement of the plant is more or less settled, analytical piping work has advanced beyond the process flow stage, and engineering flow diagrams are being prepared.

The next operation is to determine the physical sizes for spacing and arranging the process equipment. This is rather complex because piping economy and the expense of both operating and maintaining the completed plant depend on it.

So far the result of all engineering analysis is reflected usually on one drawing, which is an intelligent guess and provides the basis of subsequent work. But after the preliminary plot plan is completed, drawing production widens into several layout studies. For the production of these layout studies, more detailed information must be supplied as well as worked out.

Data Required

In order that the plan layout can be more closely investigated and layout studies produced, the following detailed information is required.

1. Drum and tower drawings.
2. Instrument connections to vessels.
3. Heat exchanger and cooler box details.
4. Pump, compressor and mechanical equipment details.
5. Net pump suction head (NPSH) requirements.
6. Insulation data.
7. Furnace and heater details.
8. Weights of equipment that require handling.
9. Building sizes and details.
10. Requirements of underground arrangement (sewers, cable and pipe trenches, and underground lines).
11. Electrical equipment requirements (switch boards, floodlight poles, transformers).
12. Instrument requirements (lines and ducting).
13. Detailed flow diagrams.

With these details, layout studies can be produced, problems recognized and solved, and necessary changes made in the original plant layout. Generally, drawings should be completed as far as each section or department has sufficient information with which to work.

Each department is supplied certain information for the whole of design engineering on the project. The piping department is supplied with the location of all equipment and nozzles, control valves, controllers and transmitters, valves and manifolds, orifice runs and main pipe with supporting steel. The structural department will receive the location of all equipment footings, road ways and paving, trenches and culverts; also pipe loads affecting structural design; platform, staircase and ladder requirements; fireproofing and equipment handling requirements. The vessel department receives the types of all vessel supports; all nozzle, manhole and handhole locations; and loads affecting vessel design. Heat exchanger support, davit positions on exchangers, towers and manholes, as well as instrument locations, are shown. For the electrical and instrument departments, the cable runs in trenches or overhead, and switch board and instrument locations are shown.

All this information is the nucleus of plant layout and design. The execution of detail design, which follows, substantially enlarges the scope of drawing production.

Scheduling Drawing Production

To try to run an efficient production line without sufficient raw material is extremely difficult. Likewise, to operate a capable design engineering organization under extremely fluctuating work loads leads to low efficiency. The ideal is a constant work load and constant manpower, but in an engineering organization this almost never happens. But, it is advantageous at least to keep manpower and workload in a balanced relationship.

With certain available manpower, refinery and chemical plant design can be scheduled over twelve months of the year. If, for instance, a design group has an average of four similar contracts per year, then it can plan on completing within three months a contract in any one of its sections or departments. If a section takes less than three months to do its work it means the section is too large for the expected work load—or the hours estimated too high. If *more* than three months are required for the work, the reason may be inadequate manpower, too many unexpected changes during design, insufficient organization, or delayed or insufficient information was

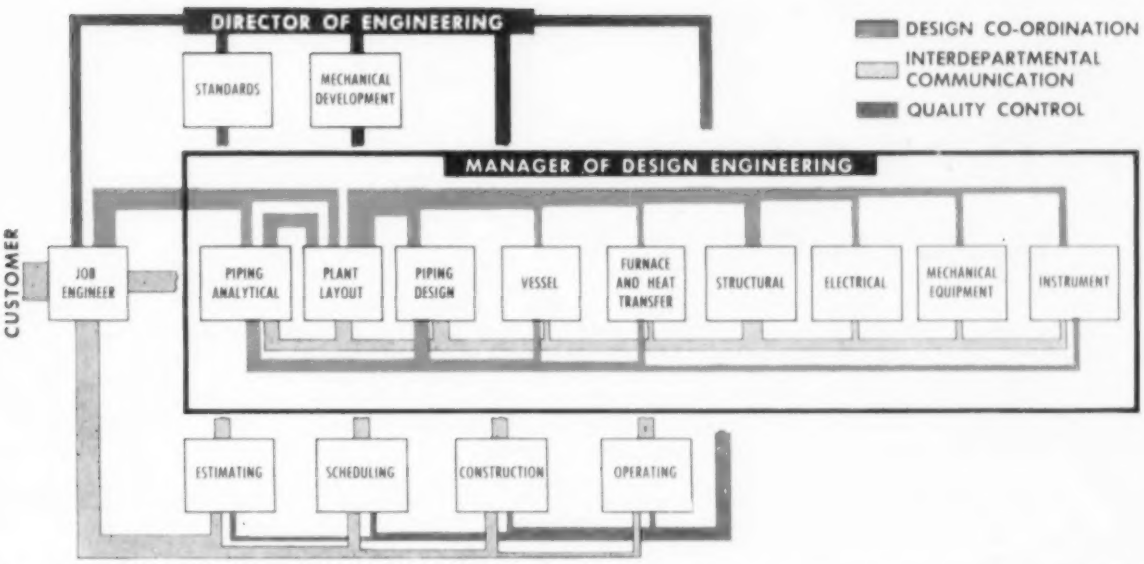


Fig. 22—**ORGANIZATION OF AN ENGINEERING GROUP** must allow for lines of communication, quality control and especially co-ordination. Volume of work flow is indicated by varying line thicknesses.

supplied. In analyzing production efficiency of either a section or a department all of these possibilities should be kept in mind.

Drawing production is normally expressed in number of drawings per unit time. As far as coordination of engineering activities is concerned, the denominator (time) is the more important of the two factors because it must be considered in both absolute and relative terms. *Absolute* refers to the total time (manhours) required to finalize the job, and *relative* refers to the calendar time (days) within which the job must be finished. Each influences the other. Although the relative time may be flexible within limits, the absolute time can only be reduced by efficiencies within the design office.

One definite relationship exists between calendar time and the organization of engineering activities—the dates selected for information transmittal. Detailed schedule dates that cover all engineering information are essential to a well coordinated production of drawings. The sequence of the dates should conform closely with the sequence of steps necessary for developing engineering design.

Office Organization

A typical design engineering organization chart, with the main flow of information and control points, is shown in Figure 22. As shown, the first contact between a new job and the drawing office is made by the job manager or job engineer. He presents the contract in the form of process flow sheets and specifications. Initial design work is performed by the plant layout and analytical piping section, each in close cooperation with the other. Liaison between initial development and the customer's requirements is maintained by the job engineer.

The initial plans present an overall picture to the customer besides providing a good start for detail design. Information flowing in and out of the department is controlled by the dept. head or his deputy. Information concerning the basic design and overall layout of the plant is controlled and coordinated by the plant layout section.

Individual performance is scheduled and checked by the department concerned. The work performed by all design departments is scheduled, progress is recorded, and time and production are checked through the scheduling department. Its main duty is to produce records that can be used for realistic predictions for the organization's time and dates, make certain the dates are practical, and that they are adhered to.

Another important role in the production of drawings is played by the estimating department before the job enters the drafting room. And, of course, the construction and operating departments both play critical roles after the job leaves the drawing office, as well as during plant layout and the course of design. Overall quality control is exercised by the director of engineering through engineering standards, methods of design and technical development.

Conclusion

The production of drawings is essentially a human effort and, therefore, may not always be reliable. It cannot be compared with the output of a series of machines. Thus, no theorizing about drawing production is acceptable unless it is practicable.

If an engineering organization takes care to work out a practical system for the production of engineering drawings it is taking a big step toward efficient operation. If the same system is established with competent work in mind it will also be geared to higher productivity. Once established the system should be adhered to by all. If, and when, improvements are discovered they should be incorporated with full knowledge of all concerned.

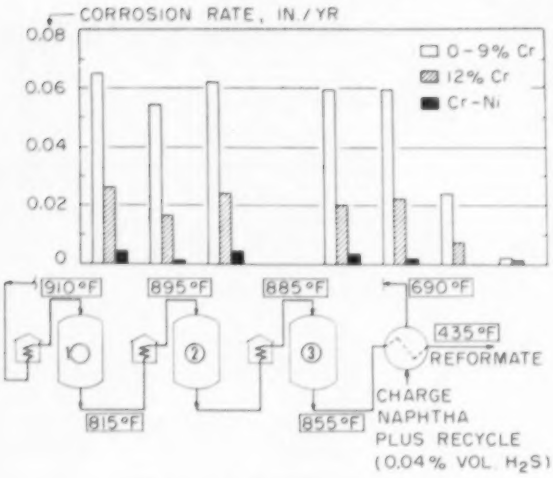
One warning: do not disrupt a working system with irregular decisions or actions. Their adverse effect will be felt throughout the entire organization and will inevitably result in less efficient, decreased production.

Acknowledgment

The author expresses his thanks to the Kellogg International Corp. for permission to publish this material. Appreciation is also expressed to my colleague, Mr. B. D. Wookey, for his valuable assistance and suggestions in the preparation of these articles.

H_2S Corrosion in Sovaformers

How bad is it and can it be stopped? Socony Mobil reports on its experience



Graphical summary of

THE USE of catalytic reforming—as a source of low-sulfur, high-octane motor fuel—has increased rapidly during the past six years, reaching over a million barrels daily.[1]

In some catalytic reformers, hydrogen sulfide corrosion has become a serious problem. An iron sulfide scale is formed at high temperatures by the reaction of H_2S (particularly in a hydrogen-rich atmosphere) with commonly used materials of construction. Usually the actual metal loss is small, but the scale formed may spall off and eventually cause plugging.

The literature on H_2S corrosion under catalytic reforming conditions is meager (German literature [3, 4, 6] has some short-term test data applicable to hydrogenation units); hence petroleum companies have had to develop their own information. Socony Mobil Oil Co., Inc. has reported results of its laboratory work.[2] These results show that H_2S corrosion can be lowered by: (1) reducing H_2S in process streams, (2) using chromium-nickel austenitic steels, and (3) protecting metals by aluminizing.

This article will report actual corrosion experience with the first two Socony Mobil Sovaformers (fixed-bed reformers using a platinum-containing catalyst).

The first Sovaformer, at the Ferndale, Wash., refinery of General Petroleum Corp., went onstream late 1954. The second unit, at Socony Mobil's Augusta, Kans., refinery, went onstream early 1955.

Laboratory tests[2] and field experience[1] indicated that corrosion metal losses would be low, but that

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Meet the Authors

Mr. Backensto

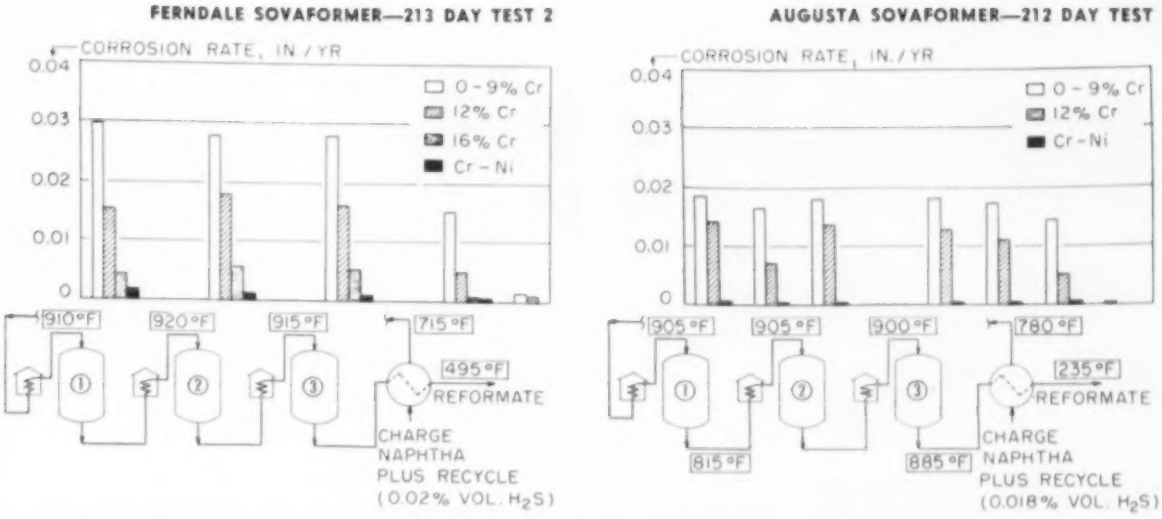
Mr. Drew

Mr. Vlachos

Mr. E. B. Backensto, Senior Engineer with Socony Mobil Oil Co. in its Paulsboro, N. J. Research and Development Laboratory, joined Socony after receiving a B.S. in Chemical Engineering from Lehigh University in 1943. He has been a group leader in charge of light products refining and treating, reforming catalyst development, and presently corrosion studies. He is a member of AIChE, ACS, NACE, API Subcommittee on Corrosion, and API Panel Chairman on "Corrosion in Catalytic Reformers and Associated Processes."

Mr. R. D. Drew, Assistant Supervisor with Socony, also at the Paulsboro Laboratory, has been with Socony since receiving his Bachelor's degree in Chemical Engineering at Yale University in 1939. Presently in charge of engineering studies of the Process Development Section, his work with Socony has been devoted mainly to the development of continuous catalytic cracking and reforming processes and catalysts.

Mr. J. N. Vlachos, Design Engineer, has been with the Refinery Engineering Division of Socony in New York since 1953, where he has been engaged in the design of Sovaformer units. His past experience includes project and design work with the Arabian American Oil Co. and the Lummus Co. He received a B.M.E. from New York University in 1944, is a licensed Professional Engineer in New York, and a member of the ASME.



Sovaformer corrosion tests

Temperatures on Sovaformer diagrams indicate locations of test racks

By E. B. BACKENSTO, R. D. DREW AND J. N. VLACHOS, Socony Mobil Oil Co., Inc.

scaling might be a problem because the only alloy used was low chromium steel (for protection against hydrogen attack above 500°F). Neither unit had desulfurization facilities, but a pretreater for the Ferndale unit was in the planning stage.

Ferndale Corrosion Experience

After Ferndale's first 50-day run, during which the H_2S in the recycle gas averaged about 0.04 vol %, the corrosion rate was measured at about 0.06 in./yr on the 1¼% chromium steels at 900°F. The metal loss was rather high, but tolerable for a short run. However, corrosion scale, about 3-4 times as thick as the actual metal loss, formed throughout the hot sections of the unit. The pressure drop had doubled across the reactors.

On inspection, loose scale carried from other parts of the unit was found on catalyst beds and in the effluent exchanger tubes. Scale had plugged about 10% of the heat exchanger bundle.

An attempt to remove scale by mechanical means was not very effective. Consequently, considerable scale remained when the unit was again put onstream.

Within a few days, the first reactor pressure drop had built up to about four times normal. The unit was shutdown to find the cause of the abnormal pressure drop. A ½-in. thick crust, mostly iron sulfide scale and powder mixed with catalyst, had formed on the catalyst. It was believed that sifting of fine powder into the catalyst not the loose scale, caused the pressure drop.

The first reactor was cleaned, and the second run continued for a total of 213 days without further difficulty.

During this run, a desulfurization unit was built for tie-in at the end of the run. The unit was designed to reduce total sulfur in the Sovaformer charge below 0.002 wt %, for which value it was anticipated that there would not be enough H_2S to form scale.

Ferndale Corrosion Test No. 1

Seven corrosion racks with 25-30 coupons of different metals were placed at critical spots in the Ferndale Sovaformer before startup. After exposure, coupons were descaled, as described previously, [1] and weighed to determine metal loss.

The results obtained are graphically summarized above; typical detailed results (for the first reactor inlet) are included in Table 1.

Carbon and low-chromium steels showed the poorest corrosion resistance, with no significant difference among the 0-9% chromium steels. Chromium-nickel stainless steels showed the best resistance. The 12% chromium steel gave intermediate results.

Fig. 2 is a photograph of a test rack from the No. 3 reactor inlet showing typical high-temperature corrosion scale.

Aluminized test specimens (calorized ASTM A 285 Grade C carbon steel and hot-dip AISI 1020 carbon

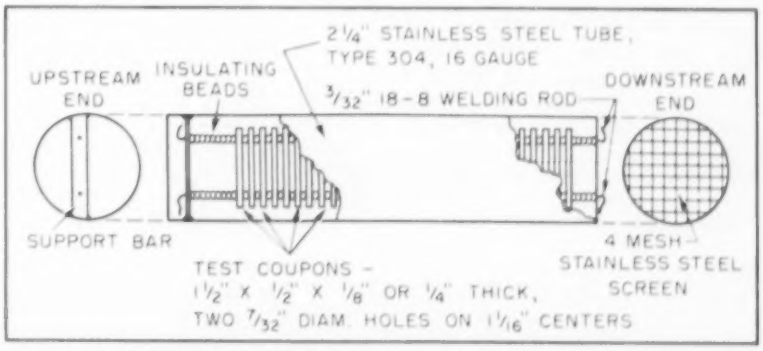

2¼" STAINLESS STEEL TUBE, TYPE 304, 16 GAUGE
UPSTREAM END
INSULATING BEADS
3/32" 18-8 WELDING ROD
DOWNSTREAM END
SUPPORT BAR
TEST COUPONS - 1½" X ½" X ⅛" OR ¼" THICK, TWO 7/32" DIAM. HOLES ON 1 1/16" CENTERS
4 MESH STAINLESS STEEL SCREEN

Fig. 1—**CORROSION TEST RACKS** used in Sovaformer corrosion tests

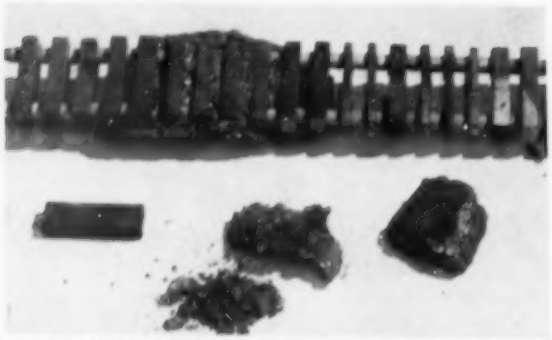


Fig. 2—**SCALE ON TEST RACK** removed from Ferndale Sovaformer's No. 3 reactor inlet after 50-day test

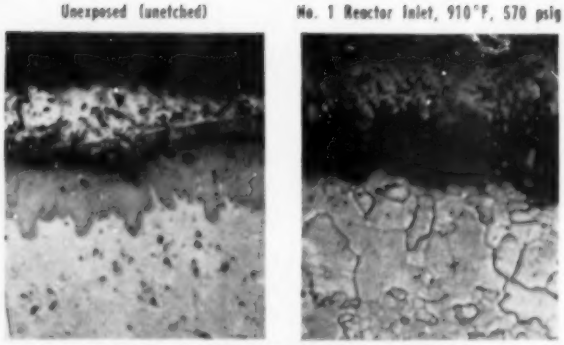


Fig. 3—**HOT-DIP ALUMINIZED CARBON STEEL** test coupon after 213 days in Ferndale's unit. Nital etched, 100x

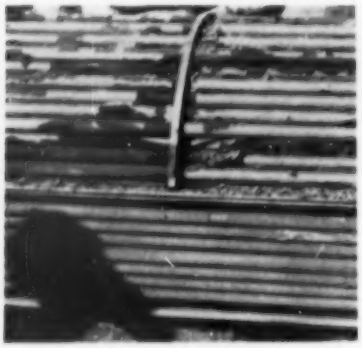


Fig. 4—**SCALE** on Augusta Sovaformer exchanger bundle after 212 days.

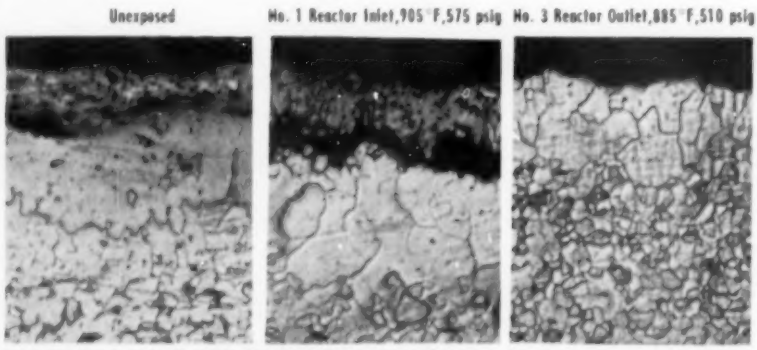


Fig. 5—**HOT-DIP ALUMINIZED CARBON STEEL** test coupons showing aluminum surface diffusion after 212 days in Augusta Sovaformer. Nital etched, 100x

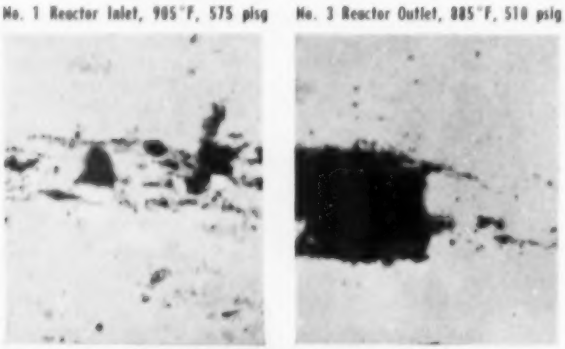


Fig. 6—**HOT-DIP ALUMINIZED CARBON STEEL** coupons showing fissuring from hydrogen attack after 212 days in Augusta Sovaformer. Unetched, 100x (only base metal)

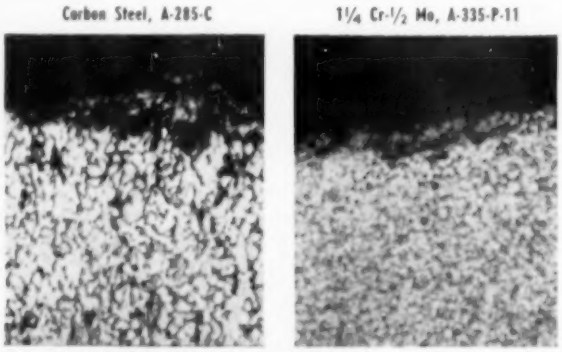


Fig. 7—**INTERGRANULAR ATTACK** of steel corrosion test coupons from No. 1 reactor inlet of Augusta Sovaformer after 212-day run. Nital etched, 100x

steel with 12% silicon-aluminum bond) showed no apparent attack or loosening of aluminum coating at any location for either type of coating.

Ferndale Corrosion Test No. 2

Because of the trouble with corrosion during the first run, a lower sulfur naphtha (H_2S=0.02 vol% in the recycle gas) was used during the second run in the Ferndale unit.

Corrosion rate data for the second test are shown graphically on p. 65 (center), and data for all the test coupons at the No. 1 reactor inlet are given in Table 1.

As in the first test, 0-9% chromium steels showed the poorest corrosion resistance, while chromium - nickel steels were best. Steels with 12-16% chromium showed intermediate results.

No aluminized specimens failed. There was appreciable diffusion of the hot-dipped aluminum coating for specimens exposed at reactor inlets, as exemplified in Fig. 3. Although the aluminum overlay and bond were no longer intact, the specimens were still protected against sulfide scaling by the diffused aluminum.

Augusta Corrosion Test

During the initial 212-day run of the Augusta Sovaformer, the first reactor pressure drop doubled. The recycle gas averaged 0.018 vol% H_2S; and the corrosion rate was about 0.018 in./yr at 900°F for steels with 1¼ to 5% chromium.

While metal loss was not considered a problem, scale formation again was troublesome. Scale was found in exchangers, piping, heaters and reactors —but in lesser quantities than at Ferndale. Fig. 4 shows an Augusta heat exchanger bundle after the shutdown. This exchanger heats recycle gas and charge by exchange with reactor effluent. The shell side is two-pass, with the hotter pass (top half of photograph) more heavily scaled.

After mechanical cleaning of the equipment, reactors were blocked off and the recycle system chemically washed to remove remaining scale. The acid wash was 5-10% Oakite at 150-160°F circulated for 20 hours, followed by water rinsing and hot-air drying. The chemical cleaning did an excellent job of scale removal.

The cleaning procedure was not completely effective, however; for the first reactor developed a pressure drop of about 100 psi within a few hours after startup. The water-wash and hot-air-drying were blamed—they probably were not effective in removing fine powder, and probably let rust form.

Unit throughput, therefore, was reduced; the unit was kept onstream for nearly two months before the next shutdown for a second cleaning. During this shutdown, catalyst in the first reactor was removed and sifted, and the system cleaned with kerosine. The next startup was smooth, and since then the unit has operated with normal pressure drop across the first reactor.

Augusta Test Results

The Augusta test program was the same as prescribed for Ferndale. A summary of corrosion results is shown on p. 65 (right). Corrosion rates were somewhat lower than at Ferndale for a similar test period. The slightly lower hydrogen sulfide level in the recycle gas at Augusta apparently made the difference.

Table 1 gives corrosion data for individual test coupons. As in the other two tests, corrosion rates for 0-9% chromium steels were highest, for chromium-nickel stainless steels were lowest, and for the 12% chromium steel were intermediate.

As in all other tests, flaky scale was evident on all test coupons having corrosion rates greater than about 0.01 in./yr. The chromium-nickel alloys had no flaky scale, the corrosion products were an extremely thin, tightly adhering film.

Scale thickness on some of the 18-8 stainless steel coupons from No. 1 and 2 reactor inlets at the Augusta Sovaformer averaged 0.0016 in., with the coupons having an average corrosion rate of 0.0006 in./yr (based on 7-month test), showing that metal loss was about one-fifth the scale thickness.

Aluminized Test Coupons

There were no calorized coupons in the Augusta test program. Photomicrographs of hot-dip aluminized carbon steel are shown in Fig. 5. These specimens were not given a heat-diffusion treatment before the test. All specimens gave adequate protection during the test.

Fig. 6 shows hydrogen attack of the base metal for No. 1 and 3 reactor outlets. No coating failure or evidence of hydrogen attack showed on micrographs of coupons from lower-temperature sections of the unit.

Hot-dipped aluminized samples from both Augusta and Ferndale came from the same plate of metal, and though the hydrogen attack was not surprising, the reason why this attack was confined to the Augusta unit is not clear.

Intergranular Attack

Several steel test coupons from the Augusta Sovaformer were examined metallographically after cleaning and weighing. The carbon and 1¼% chromium steels in unit hot sections (815-915°F) were found to be subject to intergranular microfissuring at the metal surface. At 765°F the carbon steel was not attacked, but there was slight attack near the surface of the 1¼% chromium steel.

None of the 18-8 stainless steels showed intergranular attack. Some of the coupon photomicrographs are shown in Fig. 7.

Lab versus Field Data

Laboratory data agreed well with corrosion results in the Sovaformer units. Fig. 8 summarized laboratory corrosion rate date for 0-5% chromium steels. These curves are also applicable, under Sovaformer conditions, to the 0-9% chromium steels. Fig. 9 summarizes laboratory data for chromium-nickel austenitic steel corrosion rates.

Figs. 8 and 9 represent more than 50 laboratory test runs, and each figure represents results of about 300 test coupons. Pressures for Figs. 8 and 9 were 175-500 psig, because available data at 0.1 vol% hydrogen sulfide at 985°F indicate corrosion

Table 1—Corrosion Test Results for Ferndale and Augusta Sovaformers

(No. 1 reactor inlets)

Location	Sovaformer Ferndale	Ferndale	Augusta
Length of test, days	50.5	213	212
Average conditions:			
Temperature, °F	910	910	905
Pressure, psig	550	570	575
H_2S, vol.%	0.04	0.02	0.018
Corrosion rate, in./yr			
Carbon steel, ASTM A 7	0.0538	0.0239	0.0189
Carbon steel, ASTM A 83—Type A	0.0747	0.0294	0.0188
Carbon steel, ASTM A 201—Grade A	0.0729	0.0307	0.0186
Carbon steel, ASTM A 201—Grade A	0.0719	——	——
Carbon steel, ASTM A 285—Grade C	0.0526	0.0248	0.0180
1 Cr-½ Mo	0.0687	0.0309	0.0196
1¼ Cr-½ Mo	0.0667	0.0293	0.0205
2¼ Cr-1 Mo	0.0703	——	0.0203
5 Cr-½ Mo (1)	0.0644	0.0296	0.0203
5 Cr-½ Mo (2)	0.0644	0.0293	——
5 Cr-½ Mo (3)	——	0.0296	——
7 Cr-½ Mo	0.0597	0.0297	0.0206
9 Cr-1 Mo	0.0576	0.0392	0.0191
12 Cr-Type 405	0.0211	0.0126	0.0142
12 Cr-Type 410 (1)	0.0306	0.0230	0.0142
12 Cr-Type 410 (2)	——	0.0107	——
16 Cr-Type 430	——	0.0041	——
18-8—Type 302	——	0.0026	——
18-8S—Type 304	0.0055	0.0018	0.0009
18-8SL—Type 304L	0.0053	0.0019	0.0010
18-8M—Type 316	0.0053	0.0013	0.0006
18-8ML—Type 316L	0.0053	0.0015	0.0005
18-8T—Type 321	0.0031	0.0013	0.0005
18-8C—Type 347	0.0045	0.0015	0.0006
18-8C—Type 347	0.0045	——	——
25-12—Type 309	0.0028	0.0010	——
25-12C—Type 309CBS	0.0022	0.0009	0.0003
25-20—Type 310	0.0020	0.0009	——
Monel	——	0.0018	——

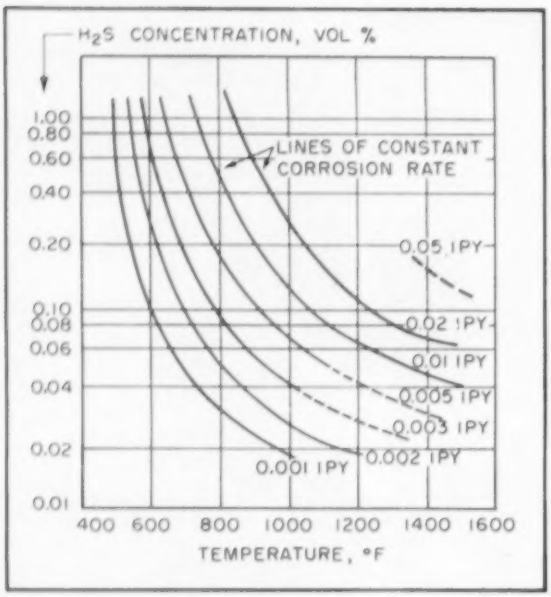


Fig. 8—**EFFECT OF TEMPERATURE** and concentration of hydrogen sulfide on corrosion rate of 0-5% Chromium steels—laboratory data at 175-500 psig hydrogen pressure

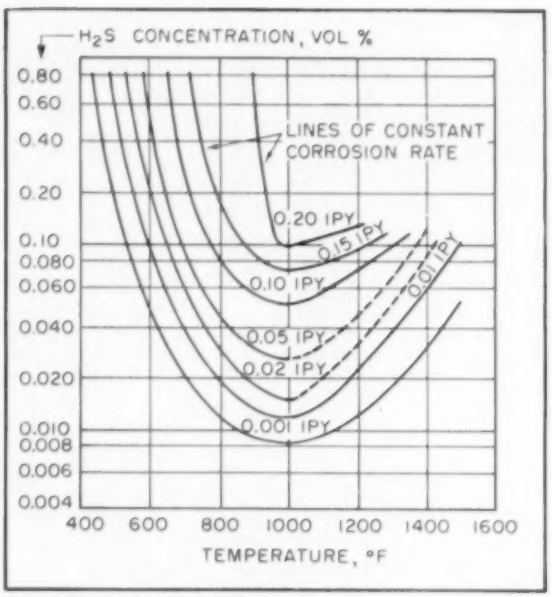


Fig. 9—**EFFECT OF TEMPERATURE** and concentration of hydrogen sulfide on corrosion rate of chromium-nickel austenitic steels—lab data at 175-500 psig hydrogen pressure

rate to be unaffected by pressure in this range.

Table 2 gives a summary of corrosion rates at 900°F in the Sovaformer tests. Comparison of these with Figs. 8 and 9 illustrates the reliability of the laboratory data for predicting actual field results.

Laboratory data for the 0-5% chromium steels predict slightly higher corrosion rates than occurred in field tests; this is normal—short-term laboratory corrosion rates were expected to be somewhat higher than for the long-term field tests. A previous paper[2] shows that sulfide scale on 0-9% chromium steels gives some protection against further corrosion. For chromium-nickel steels (Fig. 9), field results were somewhat higher than laboratory test predictions.

For low-chromium steels with hydrogen sulfide below about 0.1 vol%, Fig. 8 curves show that the corrosion rate has a maximum at about 1000°F as temperature is increased. If there is a maximum corrosion rate for the chromium-nickel steels (Fig. 9), it will occur at a higher temperature than for the low-chromium steels.

Control of H_2S Corrosion

As a result of field and laboratory corrosion test, most Sovaformers now have a pretreater to desulfurize the charge below 0.002 wt% total sulfur. At this sulfur level, corrosion on carbon and low-chromium steel will be negligible in the Sovaformer.

In pretreaters, where the H_2S concentration may be high, low-chromium alloys are used between 550 and 850°F for hydrogen sulfide levels up to 0.03 vol%. Under these conditions, metal loss is not a problem, but scale formation is. Methods now being tried to reduce scale formation include aluminizing in a way to make a satisfactory bond—preferably a diffused bond—and mechanical devices to remove scale from process streams.

For hydrogen sulfide above 0.03 vol% and above 550°F, where a high corrosion rate would mean short equipment life for low-chromium steels, the use of 18-8 stainless steels is indicated. However, above 800°F, even 18-8 chromium-nickel alloys corrode at rates above 0.01 in./yr, giving excessive scale formation.

Table 2—Summary of Sovaformer Test Corrosion Rates—900°F

	Time Days	Hydrogen Sulfide in Recycle Gas, Vol.%	Corrosion Rate, in/yr 0-9% Chromium Steel	Chromium-Nickel Steel
Ferndale	50	0.04	0.060	0.004
Ferndale	213	0.02	0.025	0.002
Augusta	212	0.018	0.018	<0.001

Acknowledgment

The authors wish to express appreciation for assistance given in this work by the staffs of the Ferndale refinery of the General Petroleum Corp., and the Augusta refinery and Research and Development Laboratory of Socony Mobil Oil Co., Inc.—especially to J. E. Prior who conducted the metallographic examination.

References

(1) Backensto, E. B.; R. D. Drew; R. W. Manuel, and J. W. Sjobert, "High Temperature Hydrogen Sulfide Corrosion in Thermofor Catalytic Reformers," *Corrosion*, 12, No. 5, 235-244 (1956).

(2) Backensto, E. B.; R. D. Drew, and C. C. Stapleford, "High Temperature Hydrogen Sulfide Corrosion," *Corrosion, 12*, No. 1 22-32 (1956).

(3) Baukloh, W.; and E. Spetzler, "Iron and Some Ferrous Alloys Attacked by Gases Containing Hydrogen Sulfide" *Korr. u. Metalsch, 16*, No. 4, 116- 121 (1940) (Henry Brutcher Trans. No. 3408).

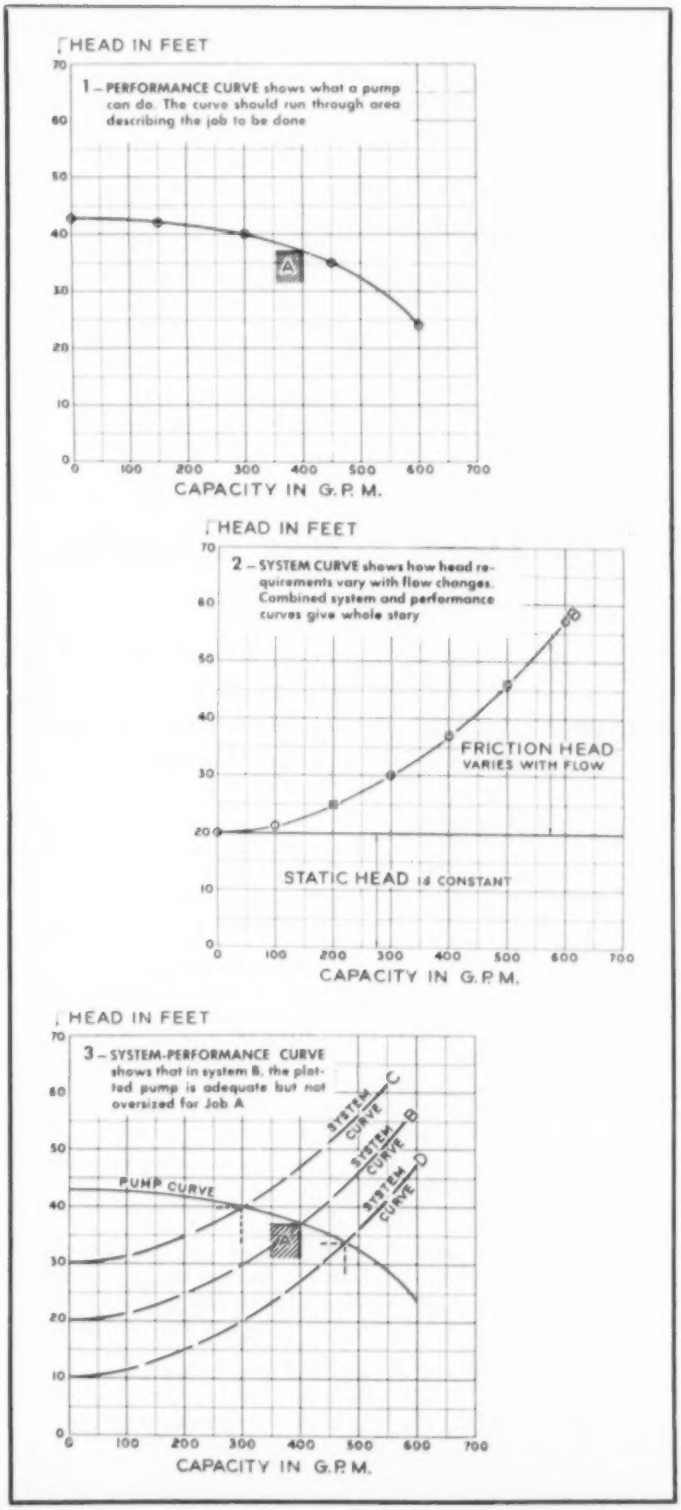
(4) Dittrich, E., "Concerning the Influence of Pressure on the Attack of Steel by Hydrogen Sulfide. II. Ferrochrome. Ferronickel," *Die Chemische Fabrik, 10*, 145-150 (1937) (Henry Brutcher Trans. No. 390).

(5) Guthrie, V. G., "Where Are We Going with Catalytic Reforming," Petroleum Processing, Aug. 1955, pp. 1157-1204.

(6) Hessenbruch, W., "Metals and Alloys for High Temperatures. Part One, Nonscaling Alloys," (Julius Springer, Berlin, Germany), Chapter VI, Corrosion by Sulfur Bearing Gases (1940) (in German).

Pick the Right Pump for the Job

By J. A. CABLE
Allis-Chalmers Mfg. Co.


HEAD IN FEET
1 – PERFORMANCE CURVE shows what a pump can do. The curve should run through area describing the job to be done
A
CAPACITY IN G.P.M.
HEAD IN FEET
2 – SYSTEM CURVE shows how head requirements vary with flow changes. Combined system and performance curves give whole story
FRICTION HEAD VARIES WITH FLOW
STATIC HEAD is CONSTANT
CAPACITY IN G.P.M.
HEAD IN FEET
3 – SYSTEM-PERFORMANCE CURVE shows that in system B, the plotted pump is adequate but not oversized for Job A
SYSTEM CURVE C
SYSTEM CURVE B
SYSTEM CURVE D
PUMP CURVE
A
CAPACITY IN G.P.M.

THE work any centrifugal pump can do is best shown by a performance curve. This curve—see Chart 1 at left—is plotted by connecting a series of points representing capacity in gpm against head in feet.

To select a pump for a specific job, choose one whose curve runs through the area representing the operating characteristics for your application—see area "A" on the chart.

You then have to accurately determine the specific conditions facing you to be sure your pump will do the job. The demands your installation will make on the pump can also be illustrated by a curve.

As an example, see Chart 2 at the left. This plots a series of points showing how head requirements vary with changes in flow through a given piping system. The head is usually a combined factor, including some difference in elevation, plus friction as the fluid passes through the system.

The elevation difference, called "static head," will usually be a constant. In this example, assume it is 20 ft. Also assume you have a 4-inch pipe line of 200-ft. equivalent length including fittings. The friction head increases with an increase in flow rate.

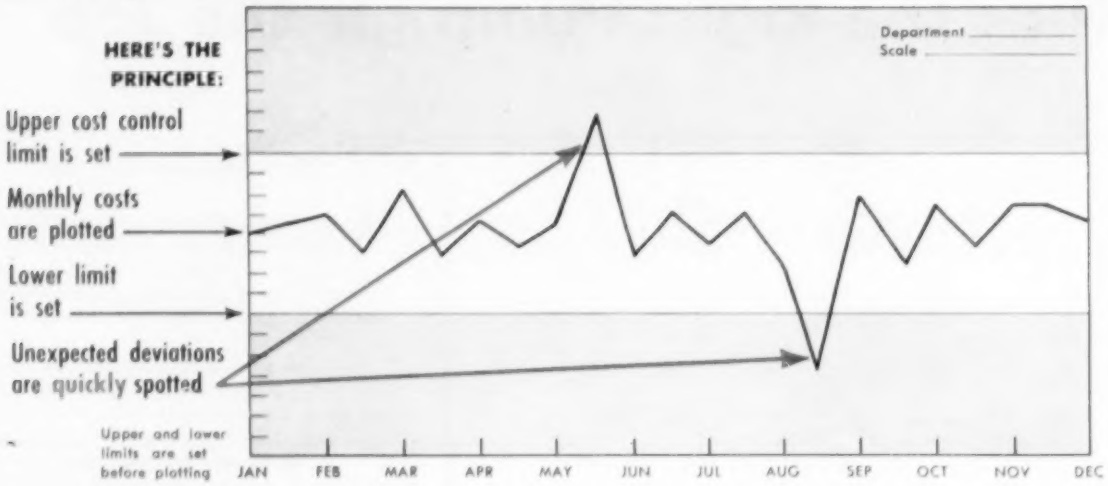
Will the pump fit these conditions? Combine the two charts into Chart 3, which also shows two other system curves—"C" and "D," where the friction head variations are the same as for system "B" but static head varies from 10 to 30 ft.

This permits rapid visualization of the job to be done and the performance capabilities of the pump. If the system behaves according to curve "B," the two curves intersect within area "A," and the pump will do the required job. If estimates were made incorrectly, or if actual system conditions are as indicated by curves "C" and "D," the pump will operate at the corresponding points of intersection—outside area "A."

The pump curve does not change, but the system curve can, thus altering performance. Varying conditions, such as differences in the source of liquid level, can easily affect performance.

So, you have to be accurate when specifying pump ratings. Or you won't be sure that your pump will perform at its best for a given requirement. Specify carefully. Do not include overly generous factors of safety, "just to be sure to get a pump big enough." This could result in obtaining a pump incapable of doing the job at all.

Running cost control AT A GLANCE



'Instrument Charts' Track Costs

By J. N. WATSON
British American Oil Co.

It's new and important. British American in Canada has developed a control system that applies, for the first time, particularly efficient statistical methods to refinery cost control. Results to date are encouraging

HIGHLY DEVELOPED process control, based on instrumentation, is permitting small teams of operators to observe and control large, complex processes. A similar technique is being developed at British American Oil Co. Ltd. for the control of refinery operating expenses. These costs, instead of appearing in the usual tabulated statement of manufacturing costs, are expressed on control charts, which do the same job that a recorder-control instrument does. They:

Record—by showing the difference between actual occurrence and a predicted standard; and

Control—by defining the extent to which actual expense may be expected to fluctuate from the standard through the influence of random cause.

Basically, our approach was to establish from past experience a standard cost for each operation. This value (adjusted for activity level where required) became the control point, with limits established on either side. Any expense occurrence falling outside these limits then quickly points up the presence of some changed condition.

Why We Tackled The Problem

We recognized that severe limitations were imposed on interpreting and controlling expenses by the classical method of tabulated statements because of:

1) Wide monthly fluctuations that occurred in many expense categories.
2) The lack of precise and intimate knowledge of the cause of these fluctuations, and
3) The unknown effects of the causes.

When expense data is expressed in terms of cents per bbl of throughput or volume handled, it may give an erroneous picture. We found, instead, that expressions in terms of quantity (in our situation, total dollars) provided much closer functional correlations. And our experience has been that intensity or ratio variables rarely bear linear relationships. As a consequence, they frequently tend to ridiculous extremes, and all significance from a control standpoint is lost.

Even though the uses of "dollars per unit of throughput" in expressing expense has been common practice in the petroleum industry for many years, the example in Fig. 1 graphically shows how this may lead to misconceptions as to true expense relationships. Many categories of expense do not have a constant ratio at varying levels of activity.

We also felt that tabular data, even in its best form, did not lend itself to ready analysis as to trends or relative position with respect to past or predicted performance. We would not, for a minute, suggest that an operator control his process unit only by means of data recorded on a log sheet. Yet, in many respects, we do the same thing when we expect management or supervision to control operating expense from tabulated statements.

Finally, presentation of expense in tabular form required examination of *all* the data and the *whole* area of expense.

In an actual situation, however, we need be interested only in the extent to which the cost behavior varies from a normal or predicted level, and the

categories or areas where such abnormal variation took place. Therefore, we proposed to establish cause-and-effect expense relationships, as far as it was possible to do so. From these, normal expense levels could be predicted. We could then scan and predigest the whole expense experience for management and supervision in a way that would isolate and highlight for them the incidence of abnormal variation.

How Our System Developed

Solving the problem of expense presentation and control came about through a team approach in our Operations Control Group. The original idea to apply the techniques of statistical analysis to this problem came from the Operations Control Administrator, Mr. W. J. McGuire. The operations research section provided technical development and instruction, and our control standards section furnished the practical experience and knowledge required for final development and application to refinery operation.

We knew that inherent in most of our expense categories was a constant cost (in Fig. 1 this fixed cost is the $3/bbl of crude), that was not influenced by any change in operating conditions or levels. There was also an unallocatable portion, which might be tied into irregular changes in efficiency. We knew, too, that there was a dynamic and fluctuating portion from changing conditions or activities.

We defined changing activities as of two distinct types:

1) *Assignable:* those of a predictable, re-occurring and significant nature, which, in most cases, could be identified and evaluated in terms of their influence on expense; and

2) *Random:* those of a non-predictable or chance character, and usually of smaller magnitude.

In our application, we may say that the affect of assignable cause can be predicted, measured and brought under control. Whereas, random cause is completely unpredictable within the sense of these terms.

Recognition of an area of random cause fluctuation around a standard is necessary, however, if we are to avoid wasting time and effort in searching out reasons for expense variations that have no real or lasting significance.

We believed that it was possible, through application of the statistical technique of correlation of one or more variables, to isolate and relate the effect of assignable cause influences. In so doing we felt we could separate the dynamic, changing portion of the expense from the constant or unallocatable portion. We also believed that the area of random deviation could be established through the application of statistical control limits, like those widely used in Quality Control work.

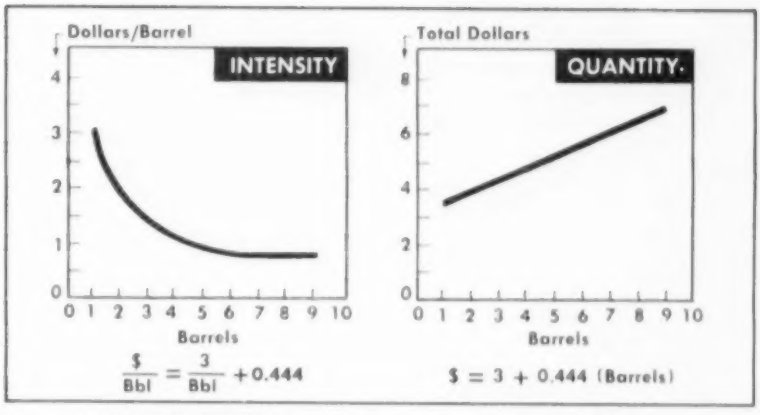


Fig. 1—**OPERATING EXPENSES** can be expressed in terms of intensity, or in terms of quantity. The two methods are compared above

Standard costs established in recognition of these principles would then be at a predicted level of cost that would include the effect of assignable cause influences; random fluctuation would be defined by control limits. The result, when expressing expense occurrence graphically, in terms of difference between actual and standard, would bring any abnormal variations into sharp relief.

What Base for the Standards?

A final decision we made before embarking on our program was the basis on which we would establish our standards. Should they be based on theoretical principles, or on statistical analysis of actual performance? We decided for statistical analysis of actual performance.

In making this decision we were well aware that what we had already been doing might have been good, bad or indifferent in an absolute sense, and that standards produced from this source would have the same values in the absolute sense. However, we knew that any attempt to establish ideal standards would require careful examination of past data, if they were to be at all realistic.

Secondly, the work involved in such an approach would seriously handicap the introduction of the control chart method for recording and controlling costs. So-called "ideal" standards, however carefully determined, would lend themselves to considerable argument over practical accomplishment.

How BA Used to Control Costs

DETAILED EXPENSE FIGURES used to be tabulated monthly by the accounting department and expressed in terms of total dollars, and dollars per unit throughput. These figures were available for many years. The established procedure was to classify refinery operating expenses under two main headings: "Direct" and "Indirect". Listed below on the left are some typical "Direct" expenses.

The expenses from these two main categories were distributed to each department or area in which the cost was incurred. In general, these accounts conformed to the physical divisions of the refinery, although a few recorded cost of activities common to the entire refinery. These departmental accounts numbered up to 42 separate headings in a large refinery. Listed below on the right are typical departmental accounts.

Hourly Labor—Operating
Hourly Labor—Repair
Salaried Labor
Material & Supplies—Operating
Material & Supplies—Repair
Fuel
Utilities—Electric Power
Utilities—Steam
Utilities—Water
Chemicals—Processing
Chemicals—Treating

Asphalt Oxidizing
Asphalt Packaging & Handling
Catalytic Cracking
Catalytic Reforming
Fire and Plant Protection
Gasoline Treating
Industrial Relations
Office
Steam Generation
Storage and Pumping
Tank Car Loading

Terms Used—

Correlation Coefficient
The test for significance of an apparent relationship.

Degrees of Freedom
The number of observations minus the number of constraints.

Factors for Control Charts
In our application, Table V, page 188 "Industrial Experimentation" —K. A. Brownlee (Chemical Publishing Co., Inc., New York, N.Y.).

Limits
Probable limits of random fluctuation on either side of the predicted value.

Regression Coefficient
The amount by which Y will vary when varying X by one unit, if X and Y are dependent variables.

Student's t
The value used to judge the probability of a correlation occurring purely by chance.

Three-Month Range
The difference between the largest and the smallest values obtained during the three-month period.

Variance Accounted For (%VAF)
The part of the variability that can be associated statistically with defined causes.

Fig. 2—Formula for Calculation of Standard Cost with one Variable

Data based on 24 observations (n), where:

y=Cost per month, in thousands
x=Drums painted per month, in thousands

A—*Sums & Averages*

$\Sigma(y) = 92.1 \qquad \bar{y}=3.8375$
$\Sigma(x) = 163.7 \qquad \bar{x}=6.82083$

B—*Sums of Products*

$\Sigma(yy) = 378.93$
$\Sigma(xx) = 1180.59$
$\Sigma(yx) = 652.02$

C—*Correction Factor*

$\bar{y}\Sigma(y) = 353.4338$
$\bar{x}\Sigma(y) = 628.1984$
$x\Sigma(x) = 1116.570$

D—*Variances*

$\Sigma' yy = \Sigma(yy) - \bar{y}\Sigma(y) = 25.4962$
$\Sigma' yx = \Sigma(yx) - \bar{x}\Sigma(y) = 23.8216$
$\Sigma' xx = \Sigma(xx) - \bar{x}\Sigma(x) = 64.02$

E—*Correlation Coefficient* (r)

$$\frac{\Sigma'(yx)}{\sqrt{[\Sigma'(yy)]\ [\Sigma'(xx]}} = 0.590$$

F—*Regression Coefficient* (b)

$$\frac{\Sigma'(yx)}{\Sigma'(xx)} = 0.3721$$

G—*Constant* (k)

$$\bar{y} + b(-\bar{x}) = 1.3$$

H—*Equation for Standard*

$$k + b(x)$$

Determining Standard Cost

We selected a two-year period as our "base period." This gave us 24 individual monthly costs with which to work. We recognized that a longer period would have been more satisfactory from a statistical standpoint. However, several factors dictated the use of a 2-year period:

(a) Additions and alterations to our plants, prior to the immediately preceding 2-year period on which expense data were available, produced major changes in the expense structure to a degree that would have added considerable complication to our work had we attempted to make use of more than two years' expense data.
(b) The use of such prior data under these circumstances has added nothing to our knowledge of the present situation.
(c) The work of data gathering would have increased considerably and delayed the charts.

It was necessary, first of all, to tabulate data in chronological sequence over the base period, by areas of cost responsibility defined in the organizational structure.

Certain small expense categories, shown separately on the tabulated statements, but of no great importance in themselves, were grouped together.

It might be noted here that the gathering of basic data into systematic and orderly array, suitable for application to the statistical procedures involved, is onerous, time-consuming and one that requires much care and attention to detail. However, any effort spent in proper organization and identification at this stage will more than pay for itself.

Revisions already made by our Accounting Department in the issuance of expense detail, plus the development of data processing techniques (now under study) which can be adapted to control chart presentation, will considerably ease this problem for us in the future.

Defining the Assignable Cause

Determination of assignable cause influence is very important, because this is the basis on which standards are established. Thorough understanding of the principles of the application; intimate knowledge of the system; and close co-operation with each Department Head (because the influences affecting an expense category will vary with the departments or areas involved) were necessary if the true cause and effect relationships were to be established.

No precise rules can be offered on the matter of assignable cause selection. The relationships established are empirical, and approximate the true functional relationship. Randomness introduces its own degree of variability in the presentation of expense data. No practical advantage would be gained if we attempted the almost impossible task of developing the true functional relationships in precise form (such as the laws of gravitation and thermodynamics), where no allowance for randomness is introduced by inaccurate measurements or by the vagaries of human effort.

We found that the greater portion of the variance in operation expense can be accounted for by no more than five well-selected variables. In many situations the number has been less.

It is a fact, of course, that the extent of the expense area under examination affects the number of variables that influence it. Obviously, the smaller the area of activity, the fewer the assignable causes. As the area widens, more influences come into play. A control chart on the expense activity of an entire refinery will be influenced by many activities.

In our initial stage of work we have been concerned only with the most obvious or apparent variables. Once the control charts are issued and functioning on a routine basis, we will work back through each category and area of expense and refine the standards to incorporate any assignable cause that lends itself to practical application.

For those expense categories or areas with no assignable cause influence, and subject entirely to random variation, the flat monthly average of the cost experience is, of course, the acceptable standard.

How to Select the Variables

Expense charges in any category are the dollar expression for certain activities that occur within a department or plant. As the intensity of those activities vary, so will the dollars.

The first approach is to identify the activities that produce the dollars, and then to determine if any of them are predictable and reoccurring. If they are, we attempt to evaluate them in terms of their influence on expense.

In the problem illustrated in Fig. 2 we find that the cost of paint used in a drum painting operation was the largest single contributor to the total dollars charged into the expense category of "Material & Supplies—Oper-

ating" for the particular department reviewed. The cost of paletting-lumber, drum seals, gaskets and stencils, and strapping material accounted for most of the remaining expense charged to this category. The principal operations that produced these costs were drum painting, filling and shipping, respectively, all of which were predictable and re-occurring activity.

There was certainly every reason to believe that the cost of paint and the number of drums painted would show good correlation. Also it seemed apparent that the incidence of drum filling and shipping should show good correlation. However, closer study showed that the actual purchase and subsequent expense charges for lumber, seals, etc., did not necessarily occur "in phase" with the drum filling and shipping activities with which they were associated. Consequently relationship between cost and activity was lost.

In any event, it was a fact that the incidence of drums painted bore a very close relationship to drums filled and shipped, because inventory fluctuations were not great. Therefore, it seemed reasonable to assume that the variable, "drums painted," could well express the relationship of all three activities. Although accurate data on the number of drums painted and filled were readily available, the same detail on total drums shipped was not.

With all these factors in mind, and in keeping with our decision to use (in the initial phase of our work) only the most obvious variables for which accurate data was readily available, we restricted this particular application to the single variable "drums painted."

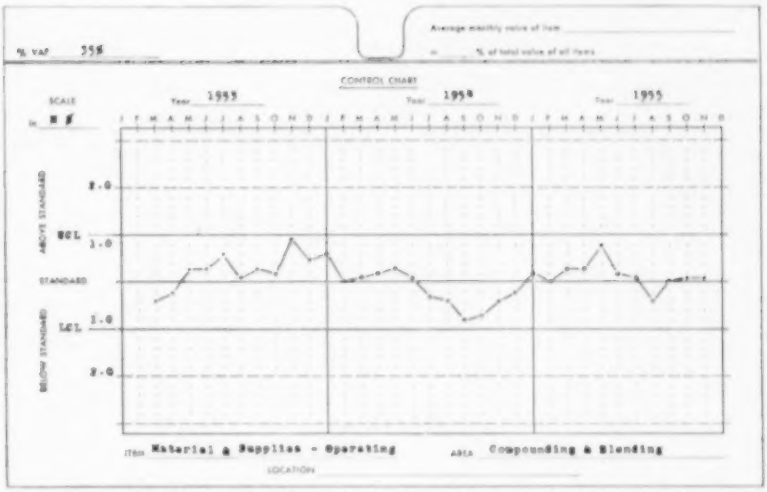


Fig. 3—**THIS TYPICAL CHART** is the final product of the cost control system. The plotted line traces the variation from standard, anticipated expense of operation material expense. The standard is correlated for one variable

Standards, Deviations, Limits

The application illustrated in Fig. 2 is based on data gathered over a two-year period of operation, and it will be observed that we obtained correlation coefficient of 0.590. Because the required value of the correlation coefficient at the 5% level is 0.404, we knew a good degree of correlation existed between the monthly occurrence of the selected variable and the monthly variations in the total expense charged to this category.

Next we determined the Regression Coefficient, b, (i.e., the adjustment applicable to the variable) and the constant, k, which together define the equation for the determination of the standard: $y = k \pm b(x)$. See Fig. 2.

Using this equation we find that our standard cost for the expense category "Material & Supplies—Operating" in the Compounding & Blending Department, is made up of a constant (k) of $1,300/month, plus an adjustment of $372 for every thousand drums or fraction thereof, that are handled each month.

If we wish to complete the analysis, the subsequent steps are:

1) Calculation of the standard, or predicted cost.
2) Monthly deviations of actual from predicted.
3) Three-month running average deviations.
4) Three-month Range (R) of the monthly deviations.
5) Average Range ($\bar{R}$).
6) Control Limits, by application of the factor 0.668 for a sample of three (from the standard table of Factors for Control Charts.)

The Control Chart resulting from these calculations is illustrated in Fig. 3, on which the plotting of expense deviation from the standard has been carried forward into 1955, on the basis of the standard established on the base period 1953-54. It is seen that this expense has remained "on control" throughout the whole period and is generally tracing a satisfactory pattern.

Why Set Control Limits?

The significance of setting control limits is that we recognize the deviations from standard (effected by random cause alone) that can be expected to occur within the prescribed limits. As long as the deviations stay within these limits we need not concern ourselves with trying to explain them. However, in accepting this principle we must remember that we will expect the cost to deviate more or less evenly *above and below* the standard. If the deviation remains constantly above (or below) the standard, or shows an upward or downward trend even though remaining "in control" then some influence is at work that was not present during the base period. It then becomes necessary to determine the cause of the changed condition. If the changed cost is found to be permanent, a new standard is established

This "trend" characteristic gives a significant warning when a cost is apparently going off control, so that investigation may be started before the actual off-control condition develops.

Percent Variance

The question will no doubt come to mind as to the % of the Variance Accounted For (%VAF).

This can be calculated, in the case of a single variable application by

$$100 \times \frac{\Sigma' y l^2 - \Sigma d l^2}{\Sigma' y l^2},$$

where (y) = actual monthly cost, and (d) = monthly deviation of actual minus standard.

In the example shown in Fig. 2 we know this to be 35%. Therefore, 65% of the variance remained unaccounted for as either normal error or the influence of some other assignable cause.

The %VAF is useful as a guide only. The character of certain expense categories is such that it is not possible to account for more than a small percentage of the variance. This may be caused by either the physical nature of the operation, or the manner in

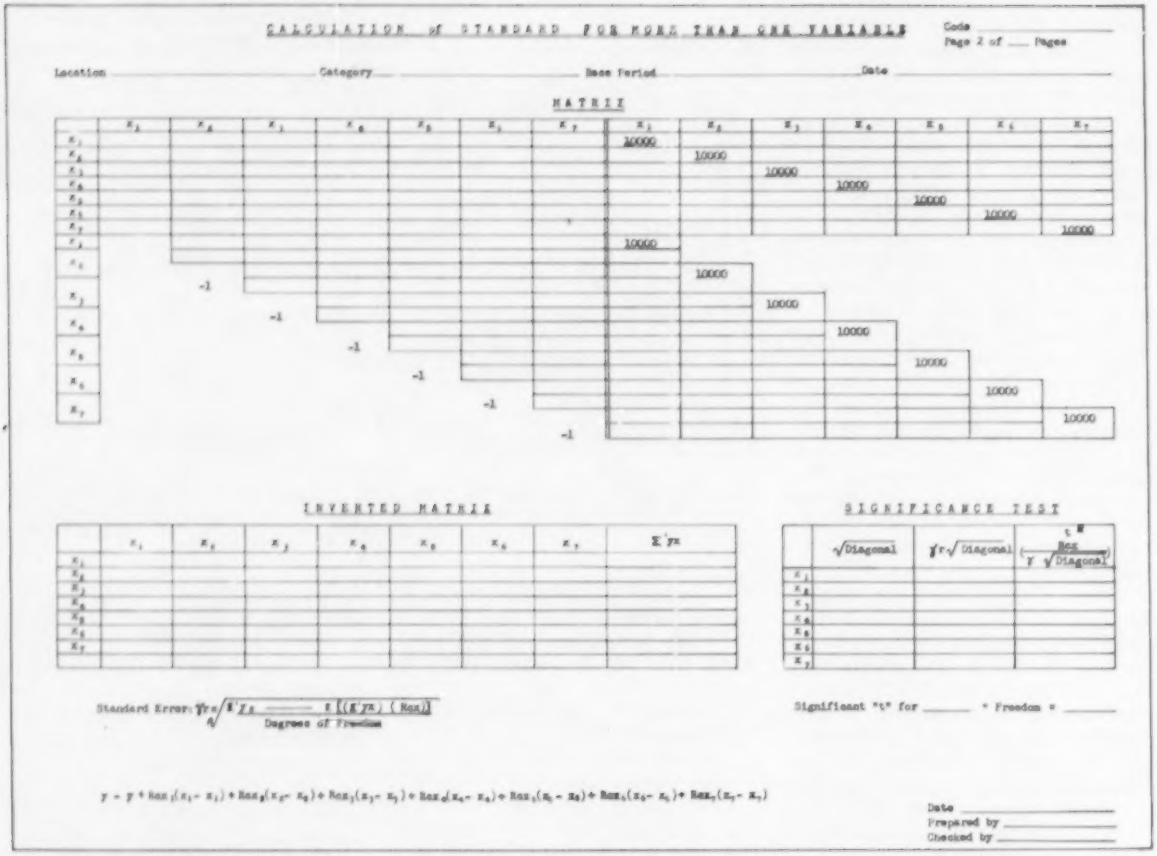


Fig. 4—**THIS FORM** is used to calculate the standard expense for more than one variable

which expense charges are made. It will be recalled that the purchases of paletting lumber, drum seals, gaskets and stencils, are "sporadic" in the statistical sense. This means expense peaks rise that do not bear a sequential relationship to the activity with which they are associated and therefore cannot be correlated.

As a consequence, the standard or predicted cost is not compensated for this occurrence, resulting in a relatively wide departure of actual from predicted.

A low %VAF indicated only that more study is required for *possible* additional assignable cause influence.

The final test, however, is the graph plotting itself. Frequent "off control" points, or a "cyclic" effect on the chart, even though the graph remains "in control," indicates that some unlocated assignable cause is at work.

In the Fig. 3 example the graph shows a good line with only 35% of the variance accounted for. We can assume, then, that we have been able to identify most of the assignable cause in our one variable, and that the character of this particular expense item is such that a considerable amount of randomness is inherent. However, this does not preclude further studies for improvement.

The term "off control" used in the sense of control chart application has reference to "statistical control." In this sense an "off control" point simply indicates that the actual expense has deviated from its predicted level to a greater degree than is to be normally expected from the experience during the base period. It does not necessarily follow that the expense is higher or lower than it should be under the circumstances that produced it.

Is a 3-Month Plot Desirable?

As we noted previously, our graph is plotted on a 3-month running average basis, and tolerance limits are calculated on the 3-month range of the monthly deviations. Thus, each graph point represents the *difference* between the average of three months actual cost experience and the average of the predicted costs for the same three months.

A variety of "random" influences introduce themselves each month in many categories of expense, so that they can at times produce fairly large but meaningless fluctuations. Because of this, a chart based on 1-month plottings could produce an erratic picture and would obscure any real trend that might be developing. The general effect would be to render the charts ineffectual as control instruments.

Will Extrapolation Work?

We should say a word on the matter of extrapolation of standards beyond the limits of the activity levels represented by the minimum and maximum values of the variables that are applied. Generally speaking, we have found that cost and variable data approach a linear relationship. In Fig. 2, for example, the minimum number of drums painted any month during the base period was 4,700 and the maximum 10,600. In 1955, the minimum was 2,900 and the maximum 8,100. Thus, the base period maximum was not exceeded, but the minimum was 1,800 below the base period low value.

However, the standard cost estab-

lished on the 1953-54 base period appears to be capable of good linear extrapolation, at least below the minimum value obtaining with respect to the variable in that period, because the chart has remained in control and has displayed a good pattern throughout 1955. If the relationship had not been linear below the 4,700 value per month, then the chart would have gone "off control." Or, at least it would have exhibited an abnormal fluctuation at the occurrence of the 2,900 drum throughput, which took place early in the year.

Our experience is that quadratic equations are not too satisfactory in the determination of standards where assignable-cause-influences demonstrate a wide range of activity levels. In such instances we have found that it is more satisfactory to calculate a standard for each separate range of the variable data.

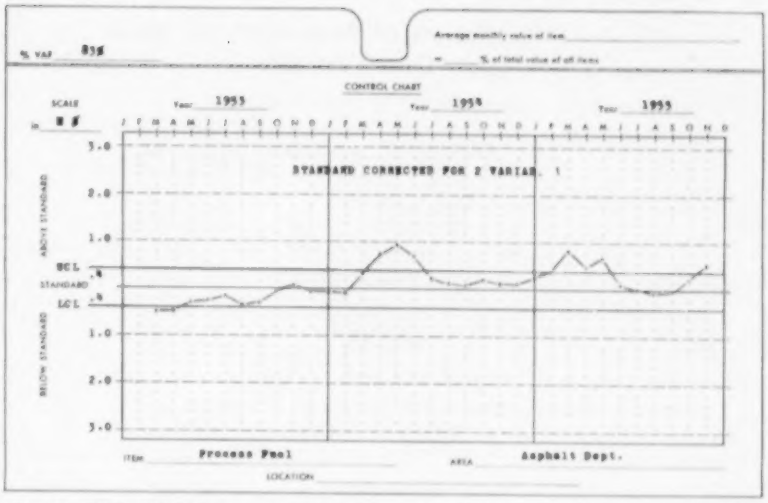


Fig. 5—**FUEL EXPENSE** here is related to a standard corrected for two variables

Applying Several Variables

Fig. 4 illustrates the second page of a form used in the manual calculation of the standard for more than one variable. The preliminary steps in this calculation are the same as those for a single variable. The first page of the form is similar to that used for the calculation for one variable, except that it is enlarged to accommodate the additional variable data and calculations involved.

Fig. 5 shows a chart for the fuel expense in an Asphalt Department, based on a standard cost developed from the application of three variables. We originally identified the oxidizing operation, paving asphalt demand, and industrial asphalt demand as the most obvious "heat consumers" in this particular operation. To test these activities for assignable cause influence, we used oxidizing still charge, paving asphalt deliveries, and industrial asphalt deliveries, all expressed in terms of thousands of barrels per month. This data was readily available and accurate. As in the single variable illustration, the data used covered the two year period 1953-54.

In this particular example we initially developed our standard in terms of "barrels of fuel consumed." This was done to avoid complications caused by fuel price changes, which occur from time to time. Having determined the standard or predicted consumption in relation to the significant variables, we then converted the barrels to dollars by simple multiplication of barrels times current unit fuel price.

In the first calculation we obtained these students' t's (significance tests) for each of the variables tested:

Oxidizing charge	6.48
Paving Asphalt Deliveries	1.55
Industrial Asphalt	1.18

Because we were working with 24 observations (n) and 3 variables, we had n-1-3 or 20 degrees of freedom, for which the required value of t at the 5% level is 2.09. Therefore, a very high correlation was evident between variations in the expense and the incidence of monthly charge to the oxidizing stills. However, the other two variables did not, at this point, demonstrate a satisfactory relationship.

We then reworked the calculation, deleting Industrial Asphalt deliveries as the variable demonstrating the lowest value for t. This produced the following results:

Oxidizing Charge	6.57
Paving Asphalt Deliveries	2.27

Significant t for 21 degrees of freedom is 2.08, so that we now had two variables, from the three selected, demonstrating satisfactory statistical relationships.

Figure 6 shows the calculation of a standard for more than one variable, following completion of the operations required on the form illustrated in Figure 4.

The procedure from this point on for calculation of deviations, ranges and limits is the same as for a single variable application.

In this example of more than one variable we accounted for 83% of the variance on the expense. However, examination of the chart illustrated in Fig. 5 shows a pronounced cycle effect in the early spring months of both 1954 and 1955, and the graph is "off control" for three months in each year at this time. We quickly determined that these peak cycles came about through inventory heating in preparation for the asphalt delivery season. This inventory heating activity was a variable we had not considered in our original work on this expense area. We must now determine if suitable, readily available data can be gathered to satisfactorily express this influence. If so, it will be tested for significance along with the original three variables tested. In the meantime, however, the chart as it stands shows very clearly the effect of the inventory heating operation and brings the occurrences in each year into sharp perspective with each other.

Charts Tie Expense to Activity

As a final example of the effectiveness of control chart presentation of expense experience, Fig. 7 illustrates the same expense history that is shown in the Fig. 5. In this illustration the expense is plotted against the arithmetic monthly average fuel cost for the 2-year period, 1953-54. A rapidly rising trend is indicated—the same general effect as would be gained from review of tabulated data. However, when the consumption of fuel is related to the activities that influence it, we get the picture illustrated in Fig. 5, from which it is apparent that fuel consumption in this plant is remaining at a fairly constant level in relation to the plant's activity, and that we are performing on the same basis as in the past.

Thus it is possible to produce, in graphical form, the relationship of actual vs. predicted expense. Because each manager and supervisor has ex-

Fig. 6—Calculation of Standard for More Than One Variable

The regression for fuel consumption was found to be:

Fuel, barrels per month

$$288 + 0.03361 \text{ (oxidizing charge B/M)} + 0.00391 \text{ (paving asphalt deliveries B/M)}$$

Converting this relation to dollars, we have:

$$\$ \text{ per month} = \frac{\$}{\text{bbl}} \left[288 + 0.03361 \text{ (oxidizing charge B/M)} + 0.00391 \text{ (paving asphalt deliveries B/M)} \right]$$

Example for calculation of standard for a month where:

Oxidizing charges	30,000 bbl
Paving asphalt deliveries	53,700 bbl
Fuel price	$3.50/bbl

Substituting for levels of activity and price, we get:

$$\text{Standard } \$ = \$3.50 \left[288 + 0.03361\ (30{,}000) + 0.00391\ (53{,}700) \right] = \$5\,271$$

The actual charge for fuel in this month was $5170, or $101 less than Standard.

pense charts for all categories or areas under his direction, he is able to see quickly the whole area of his expense experience each month. Abnormal incidents or trends are brought into sharp relief and attention focussed where it is required. No time is wasted "looking at everything," nor in attempting to decide whether a fluctuation does or does not require investigation.

Correction for assignable cause narrows the area of "off control" investigation still further, because it is a relatively simple matter to determine if the level of any of the assignable cause influences in that month are outside the ranges prevailing during the base period and, if so, to ascertain whether that is the cause of the off-control point. If not, then the supervisor knows that some other influence has occurred, and he is spared the checking into the activities for which assignable cause correction has been made.

How the Charts Are Used

The focus of our expense control is through the categories. Top management has control charts for the whole departmental expense in each category. From these, the expense experience in that category can be readily traced down to each refinery and to the individual departments within the refinery. This flow is demonstrated in the diagram below.

Department Manage't.
Total Departmental Category Charts
↓
Refinery Manage't.
Refinery Category Charts
↓
Refinery. Superv.
Refinery Dept. Category Charts

Since the total cost of all categories is also accumulated by refinery, and by refinery department, on "Total Direct Expense" charts, it is possible to survey the expense experience from this perspective also. Thus top management will have a control chart on the whole direct expense of the entire department, and there will be similar charts for each refinery and for each refinery department.

Category charts for the refinery as a whole are made up from deviations between the total expense charged to each category, and the sum of the cost functions established on the same category for each refinery department. Category charts for the entire Manufacturing Dept. operation are arrived at in similar fashion, applying the sum of the cost functions previously determined for the category at each refinery.

Similarly, "Total Direct Expense" charts for each refinery department are based on the sums of the cost functions for each expense category within the department, and so on.

Three month running average deviations, ranges and limits are then calculated in the usual manner for plot points and control limits.

In this way the effect of all the assignable cause influences used in computing standards in each refinery department is reflected in the total chart. Many of the assignable causes found significant when related to smaller cost areas would not show correlation when applied to the expense for the area as a whole.

The System Is Flexible

There is much more that could be said on this subject, on both technical and procedural details and problems, but it is to be hoped the examples cited will demonstrate the basic principles of the application.

Apart from the specific use of the statistical techniques involved, there are no hard and fast rules. A thorough knowledge of the system and principles and the application of good common sense in their application are the most important requirements. There are, of course, many good reference books on the statistical techniques used. "Industrial Experimentation" by K. A. Brownlee (Chemical Publishing Co., Inc., Brooklyn, N. Y.) and "Facts From Figures" by M. J. Moroney (Penguin Books, Harmondsworth, Middlesex, England) are two to which we have made considerable reference.

At this date we have been at work on the program about 18 months. In that time we have developed and issued a complete set of charts to all levels of management and supervision covering the operating expense activity at our Montreal East Refinery, and are just now ready to issue similar charts on our Clarkson Refinery Operations.

Because the initial application was made at Montreal East, a good deal of development work was involved and most of the computational work was performed manually by the use of desk calculators or comptometers. Elapsed time from inception to chart issuance was about one year.

Electronic Computation Needed

With the knowledge and experience gained at Montreal East, we were able to plan the approach and assemble the data for Clarkson in a much more systematic and orderly fashion, and most of the computational work was done with the aid of electronic techniques. Elapsed time from inception to chart completion in this case was 3 to 4 months and this time will be reduced considerably in future. For this purpose we employed the services of outside consultants (K C S Data Control, Limited, Toronto) and the electronic data processing machine at the University of Toronto.

The mass of data involved and the complicated nature of the multiple correlation calculations, particularly where 3 or more variables are examined, are such that the use of electronic computation is essential if any reasonable headway is to be made, especially in the initial or development stage. To maintain the application on a routine basis will require the use of punched card-tabulating machine pro-

cedures in addition to electronic computation, and the whole data gathering and processing operation is under review from this aspect at the present time.

What's Ahead

While we believe control charts will eventually replace much of the expense data now presented in tabular form—indeed, they must do so, if the time and effort expended in their production is to be worth while—they will not in any sense replace financial statements. Certain vital statistical data must always accompany the charts. However, as we progress with the work and as our standard costs are improved and refined, it is our belief that reference to detailed tabular data will be necessary only for special study or analysis. Good expense control and understanding can be exercised, for all practical purposes, through the control charts by all levels of management and supervision with very little reference to statistical detail.

As we gain knowledge and understanding of the expense functions in our refineries through the work involved in the development of cost standards (and this is a very real benefit that derives from this work), we believe also that we will find some of the information now being accumulated and published to be irrelevant to expense understanding and control. Eventually, therefore, data accumulation can be restricted to information of practical significance.

The same techniques as are being applied to expense recording and control are also being used for the development of yield functions, and for loss and utility control programs. Eventually, these will be brought together into a functional operations control "loop," in which planning and control procedures will operate at a routine level once policy has been laid down.

Our Conclusions

As so often happens when translating theory into practice, many problems of technique, procedure, and presentation remain to be worked out or improved. But, we can say with assurance now, that we have a method by which expense data can be presented to provide a ready and effective means of control.

One is very apt to be optimistic with estimates of time, man-power and money that must be spent before tangible results became evident, and in this we can claim no exception. However, we are fortunate in a most respective and patient management, and in the complete co-operation shown us by all line and staff groups with which we have had to work. We are also fortunate in the combination of experience and technical knowledge that we have been able to bring to bear on the problem, without which it would have not been possible to conceive and produce the Control Chart application. We are particularly indebted to Mr. E. E. Sorensen, Operations Research Supervisor for our Company, not only for technical instruction and guidance in the application of the techniques, but also for his advice and counsel in the preparation of this paper.

Training personnel—"selling" the ideas—the natural hesitancy to discard the familiar for the new—are all obstacles that must be met and overcome, and require plenty of time and persistence in the doing. The relative lack of prior knowledge imposes exploratory work on all phases of the application and demands much patience and hard work, and at times gives one the feeling of being an explorer on an uncharted sea. While the eventual form of the procedure and presentation may well be much different from what we now see it to be, we have no hesitancy in predicting that the use of Control Charts in the presentation of operating expense will produce improvements in examination, understanding, control, and prediction that will far outweigh any effort and cost involved in their application.

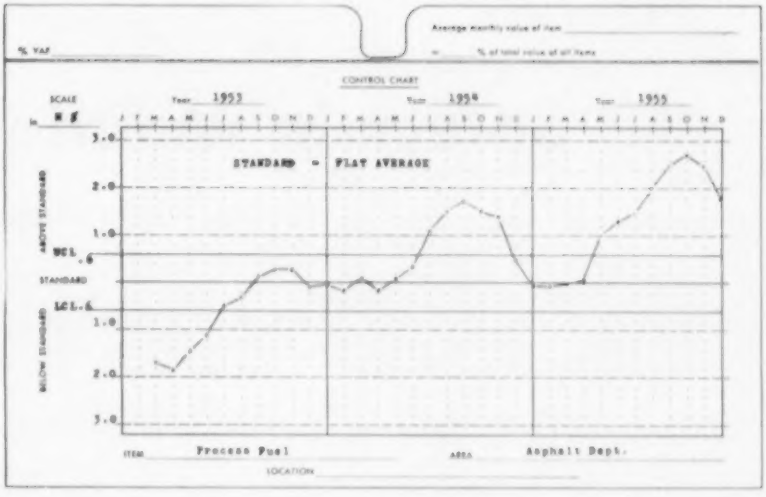

CONTROL CHART
Year 1953
Year 1954
Year 1955
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
STANDARD = FLAT AVERAGE
ABOVE STANDARD
BELOW STANDARD
UCL +.6
STANDARD
LCL -.6
Process Fuel
Asphalt Dept.

Fig. 7—**HERE**, fuel expense is related to a flat average

Meet the Author

J. N. Watson

John N. Watson is Supervisor of Control Standards in the manufacturing department of British American Oil Co., located in Toronto. Prior to starting the new work described in this article he served as assistant to the manufacturing vice-president, and as a specialist in the accounting department.

His association with British American dates back 25 years, when he was first employed at the Toronto office. A 4-year tour of duty at the Calgary refinery interrupted a continuous stay in the home office, which has included specializing in operating expense accounting and administrative procedures. The last two years have been devoted to the development and application of the operating expense control charts.

As John Watson stated in a letter to the editor of PETROLEUM PROCESSING: *" . . . so far as we can tell, this is an entirely new approach to expense control, and still in the development stage. Consequently it has not been easy to set down on paper. We hope that its publication will precipitate comment . . . and will be glad to have criticisms from your readers."*

Safety in Maintenance

. . . pays its own way–but it takes work

By J. B. ADAMS, Plant Supt., U. S. Oil & Refining Co., Tacoma, Wash.

EVOLUTION of safety and accident prevention programs has turned into revolution. Many companies have revamped their entire organization to integrate an effective program. But converting management to safety training was not an overnight job. First considerations were costs. Since World War II, petroleum and petrochemical companies have been forced to turn more and more to maintenance to cut manufacturing costs, without cutting safety.

Almost every conceivable angle has been tried to cut costs by improving maintenance. Both industry and consulting firms have studied selection and application of equipment, cost accounting methods, planning, scheduling, and personnel training programs.

But what about safety? Too often the subject of safety is omitted from maintenance conferences, or is in a minor spot during the last session. The attendance is usually a small bored group killing time until the evening plane home.

A Modern Safety Program

Many companies have found it necessary to revamp an entire organization to integrate a safety program that did not interfere with the work of running a profitable plant.

Basic to such a revamp is a system that encourages all personnel—including supervisory—to be active in the safety program.

Several excellent safety-minded organizations are used by various industry groups. The chart shows one of the most successful organizational set-ups. It integrates the safety program with the work of the entire organization. Every member, from plant manager to janitor, is an active participant.

Friction between supervisors and the safety program is eliminated by making the supervisor the "safety team captain" for his own men. He now has safety, as well as equipment and operating responsibilities.

This program lends itself well to both departmental and individual competition, making it easy to get the program into effective operation within only a very few months.

Evolution of Safety

IN THE early days, when management first saw the need for some kind of a safety program, they started on a "trial" basis to see if it would reduce accidents.

Many safety programs started when management selected some safety-minded employe to be "safety monitor." He had no authority, but tried to determine "Who was doing what things wrong."

From the casual "safety monitor" phase, the safety movement began to grow and catch hold on the plant level. However, in too many instances, safety programs continued as a step-child of the industry.

As the safety program took roots, management began to look upon it with favor. The "safety engineer" was brought in to make recommendations on job procedures. But here again was friction. The old-timers resented interference, feeling that the old way was good enough. Also, there was little enthusiasm or cooperation from the supervisors, who did not need to be "told how to run the job."

It was unfortunate for the young safety movement that World War II erupted when it did. Management's attention turned to pressing problems of emergency change-overs and increased production. The safety program was left to struggle with inexperience, inefficiency, a generally lowered work standard, and shortages of materials and properly trained personnel.

Too often the safety program drifted almost unattended during the entire war emergency—to a point of almost complete collapse .

When peace and normality returned, the safety program began to flourish immediately. It was again brought forward as the humane responsibility of industry to reduce needless suffering and loss of life and time, so common during the war era.

The successes and failures of prewartime and wartime safety programs were a basis for present-day methods.

Training the Supervisors

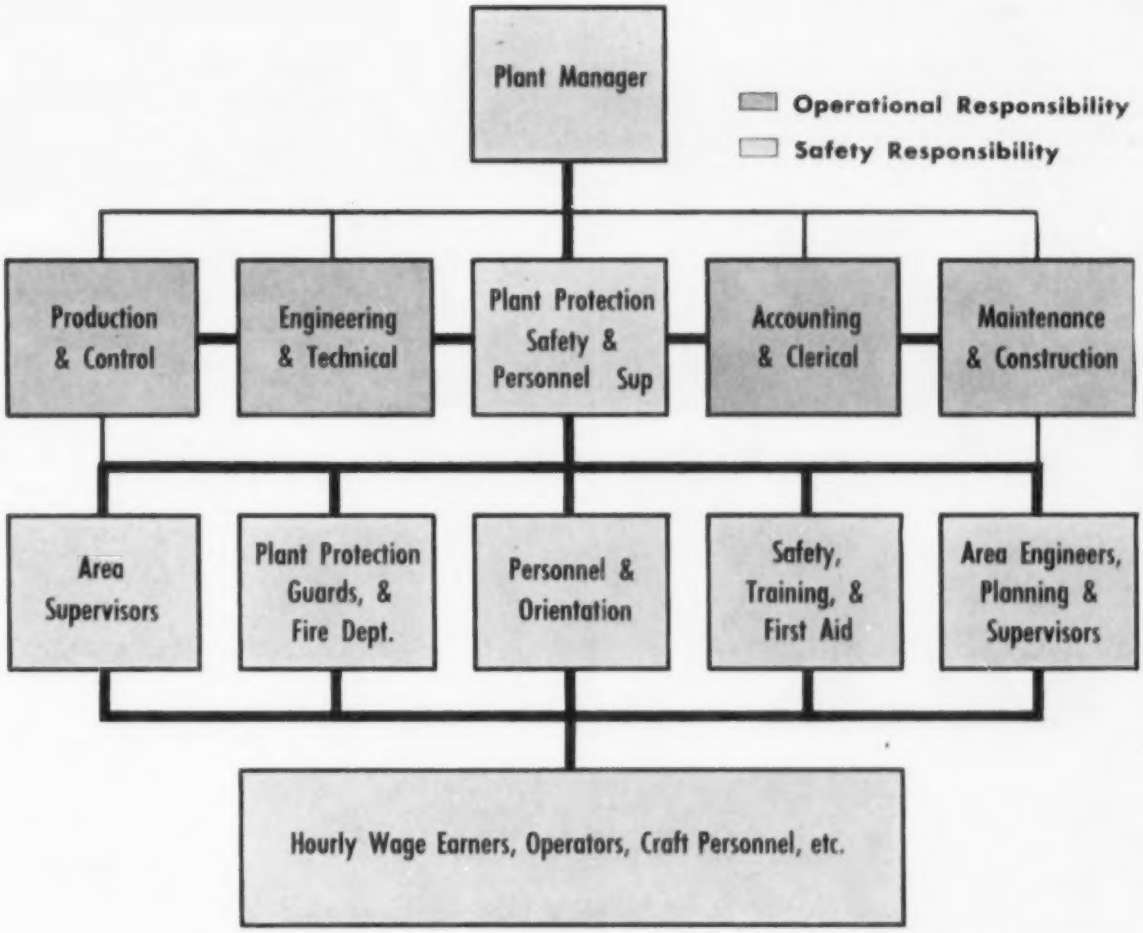
Any good program needs considerable training for all employes involved.

An early, and most important task, is to properly school all employes in the art and importance of accident prevention and first aid. A good starting point is a night class for department heads and supervisors to outline their responsibilities, as well as give fundamental safety training.

Results will be better during training if group participation is encouraged. Some control will be needed to insure even participation, with no one person hogging the sessions.

Timid group members can be encouraged to join the activities by using direct questions. This should help put the class on a fairly equal footing after the first two or three sessions.

The importance of group participation cannot be overstressed. An individual who does not enter class activities will be reluctant in discharging his safety duties in the plant. It is better to slow the whole class down a little, than to push the slower ones too much.



ORGANIZATION CHART of successful set-up showing plant safety responsibilities

Extra effort by the instructor, normally the safety engineer, can be effective in tutoring slower class members. If the safety engineer is skillful, this can be done without a feeling of inferiority by those being helped.

The safety engineer is challenged because he cannot choose his "safety team captains." They are already selected because of their positions as group supervisors. He has to make do with what comes his way.

One exception for management to remember, however, is that the entire safety program cannot be allowed to suffer because one particular supervisor will not adjust to the program.

Training Workers

Using already trained supervisors to train the workers will project the program easily and naturally. The safety engineer and management stand by to give active support to the supervisors as they train their group.

Old-timers will object less to new methods installed by their supervisors. The supervisor knows every phase of the work, as well as his men's personalities, and can present the program in the most acceptable fashion.

Better results are had when the supervisor does the training than when the safety engineer tries to "go it alone" without supervisory help or cooperation. Training for the worker level is more effective on the job than in night classes.

Safety Meetings

Planning safety meetings is one of the safety engineer's most important jobs. Safety information must be given attractively if the men are to be receptive. Films should be used to supplement straight lectures.

Many a fine safety meeting has been killed because the safety engineer feels obligated to call on every company official who shows up. Too often these officials do not know what the meeting program is, and their comments are out of place. They often repeat the information of previous sessions, or sidetrack the group by discussing irrelevant matters.

Each phase of the meeting program should be planned, and followed to completion. This does not eliminate "brief" courtesy introductions for distinguished visitors at the end of the program.

Monthly group safety meetings, ten or fifteen minutes long, should be conducted on the job by the safety engineer. These short meetings are very effective in gaining cooperation and active participation by each individual worker.

In the small group meetings, individual problems peculiar to each craft can be studied and solved. Also, these meetings encourage safety suggestions by the workers.

Keeping Interest Alive

Merit awards, both individual and group, effectively create a competitive atmosphere throughout the plant.

Company-sponsored annual picnics help emphasize combined group safety

IT HAPPENS ALL THE TIME with apologies to Jimmy Hatlo
MIKE TRIED TO BE A GOOD BOSS BUT HE THOUGHT SAFETY WAS FOR THE BIRDS UNTIL....
I BROUGHT YOU ONE OF THE NEW SAFETY HELMETS THAT WE BOUGHT!
WHAT USE DO I HAVE FOR A HELMET? THEY ARE FOR THE MEN IN THE YARD
ONE DAY HE LEARNED THAT EVEN THE BOSS COULD TAKE PART IN THE PROGRAM
WHAT HAPPENED TO THE BOSS?
SOMEONE DROPPED A NUT OFF No1 FRACTIONATOR! ONTO HIS HEAD
HERE, LET ME GET HIS TEMPERATURE

efforts, and promote needed friendship among the entire group and its families. This friendship encourages the worker to be "his brother's keeper."

Printed matter can help greatly. Periodic bulletins stimulate departmental competition, and recognize persons or groups making outstanding safety achievements. The periodical also publishes employe suggestions, and promotes plant morale—very important in a safety program.

Morale building goes hand-in-hand with plant protection, and is just as important as using safety equipment. Anything that affects an employe's ability to work safely should be considered by the overall safety program.

Safety Manuals

Each plant can benefit by compiling and distributing a safety manual. It should contain all of the necessary precautions and practices for every detail of each operating and maintenance job in the plant.

The manual not only reminds and guides plant personnel "safely," but helps greatly in orienting and training new personnel.

The New Man

The safety engineer will profit by spending as much time as possible with each new employe before his job assignment.

This time with the new man should include the issue of safety equipment needed on his particular job, and acquainting him with its use.

Orientation should also include a tour of plant safety facilities and installations, including the tool room where the new man is shown the safety tools available for his use.

Employe Relations

Combining related portions of plant protection and personnel relations with those of safety gives a larger, more diversified department with less overlapping duties.

There is division of agreement on this combination of activities, but the author, along with others, has found the three activities very closely related. They can be best, and most economically, handled under a single department head.

The author has also found better employe relations when the supervisor (directed by the personnel director) cares directly for most of the needs and problems of his own group.

A personnel director holds much more respect from the rank-and-file workmen if he can stay out of their petty grievances. These usually concern fellow workmen and are best handled by the group supervisor.

Physical Examinations

Good, rigid, physical examinations of all employes will help keep a good safety record going. The examination should include a complete back x-ray in addition to the usual cast history survey.

Literally hundreds of fictitious, lost-time, back injuries (in addition to real ones) have been charged against industry. Many of these could have been prevented if care had been taken to x-ray before employment.

Safety Pays Its Way

A safety program, such as that outlined, has paid its own way in hundreds of plants. Not only are there savings from reduced lost time, and equipment accidents, but through the greater efficiency that springs from better morale and attitudes of the workmen. This is particularly true in maintenance, where larger groups of workmen are concentrated in small areas.

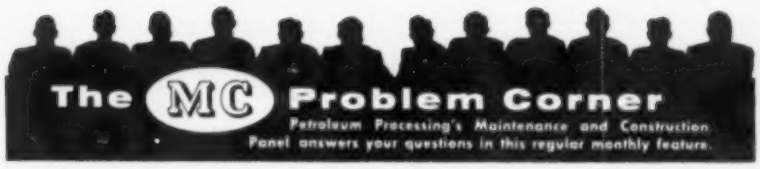
It is not uncommon for work efficiency to drop 50% as a result of a single accident during a turnaround.

The question now becomes not "How can we support a good safety program on a narrow margin of profit?"—but "How can we afford not to have a diversified, integrated, safety program?"

Meet the Author

Mr. Adams

J. B. Adams, Plant Superintendent, U. S. Oil & Refiining Co., Tacoma, Wash., was born in Union County, Ark. in 1912. He received his B.S. degree in Mechanical Engineering in 1937, and went to work for Lion Oil Co., El Dorado, Ark. immediately upon graduation. During his 19 years with Lion Oil, he served in practically every department within the refinery, but was primarily concerned with maintenance, construction and engineering work. Early in 1956 he left Lion to accept his present position in a new refinery being built by U. S. Oil & Refining. Mr. Adams is active in the American Society of Mechanical Engineers and is a member of the National Society and Arkansas Society of Professional Engineers.


The MC Problem Corner
Petroleum Processing's Maintenance and Construction Panel answers your questions in this regular monthly feature.

Fast Accounting?

. . . *Yes, If You Have a System*

Is there a simple, yet complete system for getting maintenance costs (materials and labor) the day after the job is done?

Refining, Gulf Coast

MAINTENANCE costs may be had quickly—but not easily and cheaply. After you learn "how-to-do-it" from the M&C Panel members, you'll still be faced with the question, "Is it worth it in my specific situation?"

All but the very smallest of plants will probably need punch-card accounting machines to handle the great volume of paper work with the required speed.

In one simplified approach, job labor costs are calculated the day after the job, using information from timekeeper's or foreman's daily time reports. Labor rates (actual or average), plus a fringe benefits allowance, are then applied to the job times. Labor sheets, coded to job orders, would be posted to individual cards.

Warehouse stock withdrawals are priced from perpetual inventory records, coded by job order number, and posted to job order cards the following day.

Accounting-wise, if necessary to accumulate job costs currently, each purchase order issued must be priced and coded to the appropriate job order. Materials installed during maintenance are written up on charge slips that are matched with an open file of purchase orders, priced, and posted on the proper job order card.

After completing each day's posting, cards for completed jobs would be totalled and reported.

Another plan stresses the importance of controlling maintenance work with a Maintenance Planning Section having wide authority to investigate, process, classify and schedule each maintenance work order requested by the operating department.

Work orders, in writing and with an assigned number, are processed by an Area Maintenance Engineer. He investigates, lists tools and materials needed, estimates and classifies the labor requirements, fills in the work sequence, and assigns a priority index.

A Maintenance Planning Section Meeting is then held, with attendance by all Area Maintenance Engineers, Schedule and Materials Clerks, Assistant Mechanical Superintendent, and presided over by the Maintenance Planner. This meeting makes the final work schedule, with copies to each foreman, along with copies of work orders and storehouse tickets, plus verbal explanations. The Clerks see that tools and materials are delivered to the job site in advance.

Material requisitions and daily time reports are itemized according to the schedule and identified by work order number, then routed to the planning office where take-offs are made against each job. Storehouse catalogue and classification rates give materials and labor charges.

In a plant using 24 or more maintenance personnel, this plan can often give large savings by justifying, planning and properly accounting for each maintenance operation.

Next month—more M&C Panel suggestions on rapid maintenance cost accounting methods.

Want Your Maintenance Questions Answered?

THE 12 MEMBERS of our new M&C Panel haveagreed to give answers and opinions on maintenance and construction questions sent to PETROLEUM PROCESSING.

Please make your question specific on some phase of maintenance and construction. Include a sketch or drawing if it will help. Send as many questions as you wish—but please limit each question to a single subject. Address them to:

Maintenance and Construction Editor
PETROLEUM PROCESSING
330 West 42nd Street
New York 36, New York

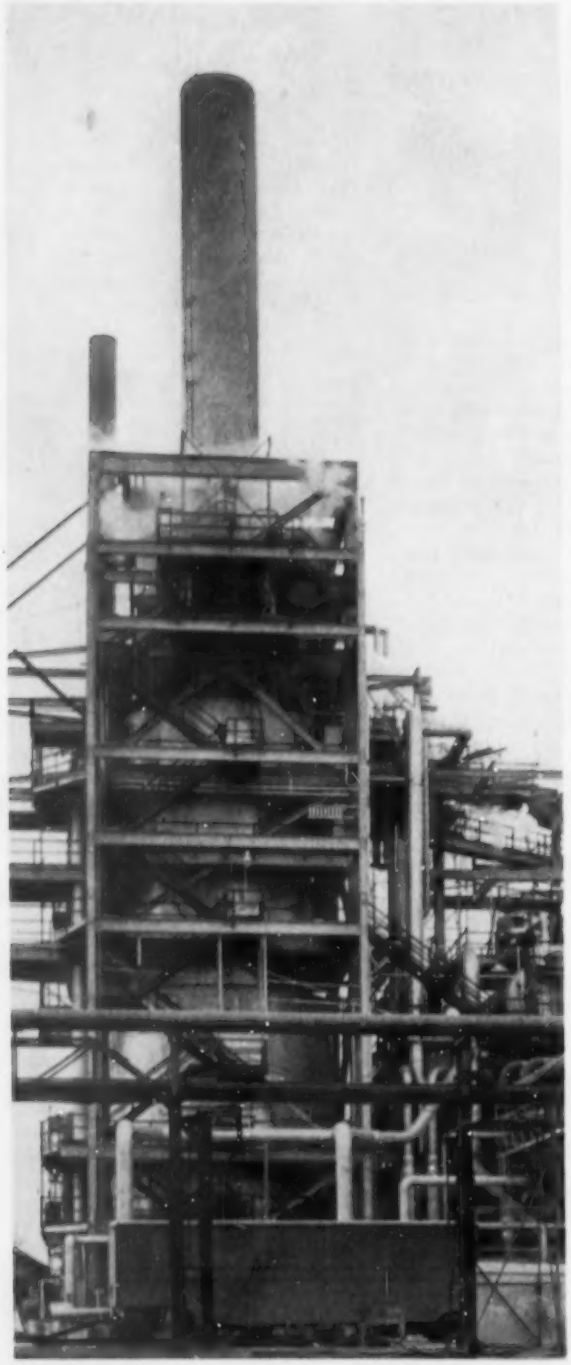
Questions will be sent to the Panel members without identifying the questioner. But please be sure to include your name and address so that we can send the answers directly to you.

The best questions and answers will be published each month in a new M&C Problem Corner—so please tell us if you wish to be kept anonymous in the event one of your questions—with M&C Panel answer—is selected for publication.

Our panel members are busy men. We can't guarantee an answer for every question, but we'll try to answer as many questions as we can.

Industry's First Circular Boiler

By N. E. PENNELS, Sinclair Refining Co.



SINCLAIR REFINING CO.'S CO circular boiler, the industry's first, has completed six months of successful operation at East Chicago, Ind.

A NEW APPROACH in boiler furnace design, aimed at more efficient use of fuels in the refinery, has now completed over six months of successful operation at the East Chicago, Ind., refinery of Sinclair Refining Co.

The unit, a carbon monoxide burning boiler with a unique new circular design, operates in conjunction with an existing 40,000 b/d Fluid catalytic cracking unit. It burns the CO in the Fluid unit regenerator flue gas and uses auxiliary fuel as needed. The boiler is designed to produce 275,000 lb/hr of 565 psig, 750°F. steam.

Circular furnaces are not new, although circular boilers are. Sinclair has long recognized the advantages of circular furnace design—over 90% of the company's still furnaces are cylindrical. However, not until the decision was made to build a CO boiler at East Chicago did the opportunity come along to interest a boiler manufacturer in the circular design.

Today, after more than six months of operation, Sinclair feels the circular boiler—especially for burning carbon monoxide—has many advantages over the normal rectangular type. These include:

1—Saving of considerable ground space, because the vertical design places the economizer, boiler tube-bank, and secondary furnace directly above the primary furnace.

2—Elimination of a water seal between the primary and secondary furnaces.

3—Meeting easily the design requirement for minimum heat adsorption from the primary furnace by covering the studded water wall tubes in this area with a 2-in. thickness of plastic refractory.

4—Simplified duct work for the CO and forced air, because CO and air distribution is an integral part of the boiler.

5—Use of a smaller amount of steel to pressurize a circular boiler—a conventional box-type boiler requires large structural beams.

Sinclair had long felt that a cylindrical boiler should provide better heat distribution and improve boiler water circulation because the circular design eliminates corners that cut down water circulation and invite internal sludge deposits.

These advantages, however, had not been sufficiently attractive to lead boiler manufacturers to development of the circular design. However, the advent of pressurized furnace boilers greatly increased the inherent advantages of the cylindrical design. It also offered substantial savings in steel by eliminating the need for the tremendous buckstays required to make a pressure container of a box. But, even this advantage did not lead to the immediate development of a circular boiler, although at least one manufacturer did make some studies.

When Sinclair decided to build the CO boiler at East Chicago, boiler manufacturers were invited to bid on a design similar to the box-type CO unit Sinclair has at Houston, Texas. A circular design was requested as an alternate.

After several conferences with Sinclair engineers, the

Completes Six Successful Months

Babcock & Wilcox Co. proposed a unique circular boiler design. This is the unit purchased for East Chicago and described in this article.

What the New Unit Looks Like

The circular boiler resembles to some extent a fractionating column. Its main components are:

1—A lower primary furnace, circular in design, where the auxiliary fuel and the CO enter.

2—A circular secondary furnace where the superheater and main boiler tube banks are located.

3—A rectangular economizer located above the main boiler tube bank.

The entire boiler and economizer are suspended from support columns. Metal expansion joints are provided between the boiler proper and the economizer, and between the primary furnace and the air and CO supply ducts. This design allows the boiler to move as required to overcome thermal expansion.

The circular CO boiler is a pressurized furnace boiler. It operates under only sufficient furnace pressure to push the flue gases through the boiler and economizer, and on up the stack.

The primary furnace has eight auxiliary oil and gas burners located at two levels of four each and arranged to fire tangentially to a small center circle. The CO-bearing gas enters the furnace through sixteen fixed refractory lined ports at two levels of eight each. The lower eight CO ports are offset below the four lower auxiliary burners, and the upper eight are offset below the four upper auxiliary burners. The CO ports fire tangentially to a larger outer circle. This arrangement of auxiliary burners and CO ports assures good mixing needed for optimum results.

The upper part of the primary furnace is necked-in to further assure complete combustion. The neck is constructed of studded water wall tubes covered with refractory. By necking in the top of the primary furnace, less heat is extracted from the primary combustion zone by the cold tubes of the secondary furnace. This arrangement gives a higher primary furnace temperature, thus aiding combustion. The neck also provides a more complete mixing of the flue gases in the furnace.

The air supply to burn the auxiliary fuel and the CO content of the regenerator gas is supplied by a turbine-driven, forced draft fan. To give continuous operation, a duplicate standby fan is provided. Boiler feedwater is supplied by a turbine driven pump that takes suction on a deaerating feedwater heater located alongside the boiler. A spare boiler feedwater pump is also provided with the unit.

The turbines driving the forced draft fan and the boiler feed pump operate condensing, with a common condenser. The feedwater is automatically controlled by a Bailey Meter Co. three-element feedwater valve. Hand control is also possible. Next to the manual feedwater control valve is the mirror for the bi-color gage, which indicates the boiler water level.

All controls are located in the Fluid Unit main control room and are of Penellit design. There is no automatic

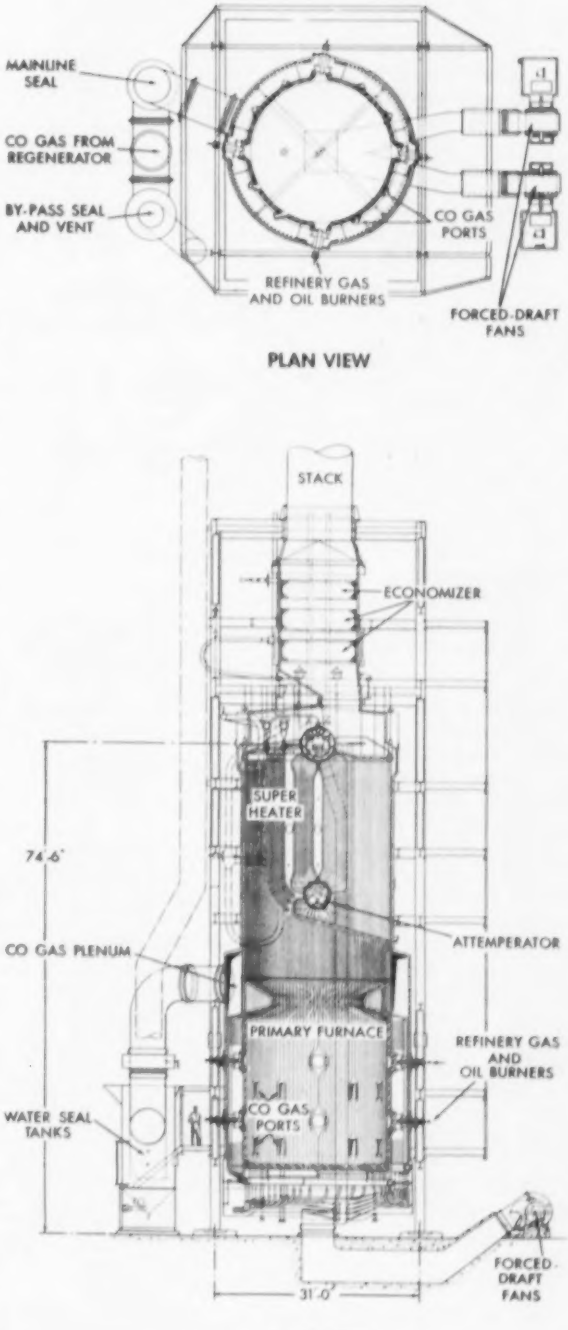


Fig. 1—**CIRCULAR FURNACE** boiler at Sinclair Refining's East Chicago, Ind., refinery has the economizer mounted over the superheater

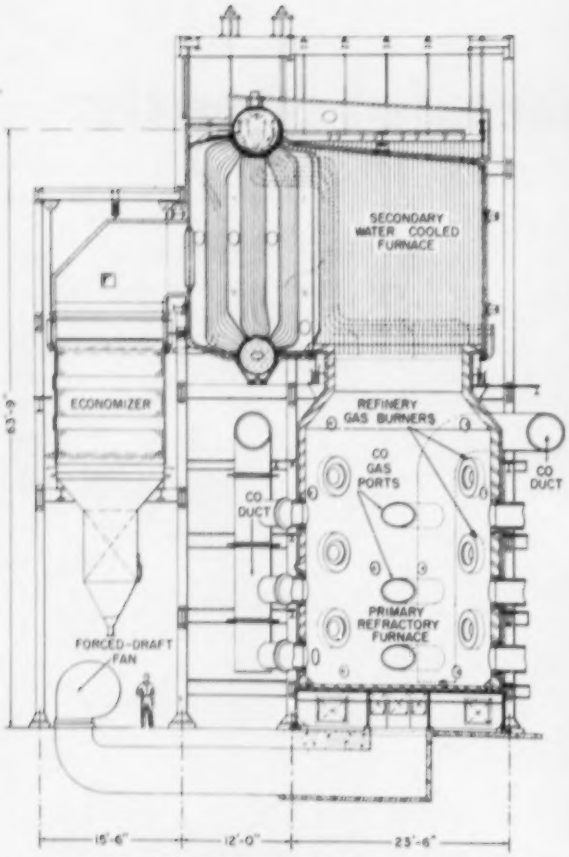


Fig. 2—**SINCLAIR'S HOUSTON CO** boiler is different, has a cylindrical primary furnace, and box-type secondary

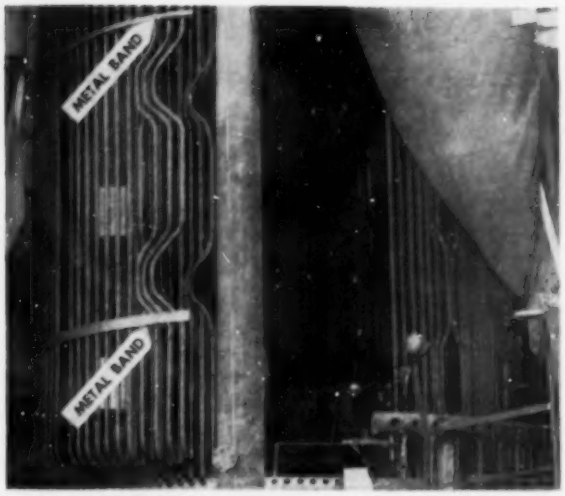


Fig. 3—**CONSTRUCTION** shot of circular boiler shows few steel bands are needed to pressurize it.

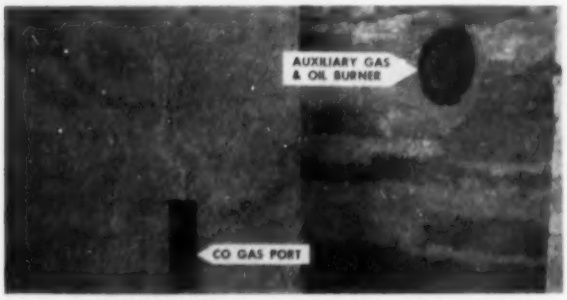


Fig. 4—**INSIDE VIEW** shows arrangement of auxiliary fuel burner and CO ports

combustion control; but automatic controls are provided for the feedwater valve, feedwater pressure, deaerator water level, deaerator pressure, fuel gas pressure, fuel gas volume, fuel oil quantity and low flow limit for boiler feedwater pumps. The unit is also equipped with an oxygen recorder on the boiler exit flue gas.

Controls are arranged so that the forced draft fans and dampers can be changed manually from the control board. The boiler feedwater pumps can also be put in and out of service from the control board. The usual alarms are provided for low or high water levels and forced air pressure. The following temperatures are recorded: feedwater entering and leaving the economizer, steam outlet and attemperator, primary and secondary furnace, flue gases entering and leaving the economizer and the entering CO gas.

The boiler is equipped with a recording steam flow meter, which records water flow and water level. A mud drum steam attemperator is used to control the final steam temperature. Retractable soot blowers are located in the main boiler bank, superheater and the economizer. A Nash low pressure air compressor is used to provide the necessary sealing air.

Design Features of the Circular CO Boiler

The CO boiler is designed to produce 275,000 lb/hr of 565 psig, 750°F steam. An alternate design condition is to produce 330,00 lb/hr of 700 psig saturated steam. The alternate design condition will permit future operation of this boiler in conjunction with a Fluid Unit regenerator to control catalyst bed temperature by superheating CO boiler steam in superheater coils immersed in the regenerator catalyst bed.

It is planned to remove, at some future date, the steam superheater from the boiler and install the steam superheater in the fluidized regenerator bed—an arrangement similar to that of the Houston CO boiler.

Figure 1 is a sectional elevation and plan view of the circular CO boiler. A sectional elevation of the Houston CO boiler is shown in Fig. 2 for comparison. Examination of these views shows the important advantages of the circular design in comparison with the Houston CO boiler, which incorporated a cylindrical refractory primary furnace, a conventional box-type secondary furnace, and single pass boiler followed by an economizer section.

The full advantages of the circular boiler are:

1. Considerable ground space is saved because the vertical design places the economizer, boiler tube bank and secondary furnace directly above the primary furnace. This arrangement is particularly desirable when installing a CO boiler on an existing Fluid Unit where ground space may be limited.
2. The integral construction of the boiler tube bank, secondary furnace and primary furnace eliminates the need for a water seal between the primary and secondary furnace.
3. The design requirement for minimum heat absorption from the primary furnace is easily met by covering the studded water wall tubes in this area with two inches of plastic refractory.
4. The CO gas and forced air duct work are greatly

simplified, because CO gas and air distribution is an integral part of the boiler. This is done by bending every other water wall tube of the primary furnace to form an annular space around the primary furnace.

This annular space is divided into eight vertical sections. Four of the sections are closed at the top and open at the bottom, and carry forced draft air to the auxiliary fuel burners. The other four sections, open at the top and closed at the bottom, carry the CO gas to the CO gas inlet ports.

5. Construction picture (Fig. 3) illustrates the tube arrangement, and give an excellent illustration of the small amount of steel required to pressurize a circular boiler. The narrow metal bands shown in these pictures are the only reinforcing required. This is in contrast to the large structural beams required on a conventional box-type boiler.

Another feature of the design is location of the economizer above the drum. Water enters the top and flows downward through two-thirds of the economizer, then flows to the bottom header and flows upward through the last one-third of the economizer. This arrangement provides for upward flow in the section of the economizer where steaming could occur, and maintains the benefits of counter-current flow of the flue gas and water to obtain more efficient use of economizer surface.

The auxiliary fuel gas burners are an improved design over those used on the Houston CO boiler, and were developed by Babcock & Wilcox for this boiler. The requirements for burner were that the electrical gas lighter, the oil gun, and the gas burner could be removed during operation for repairs or cleaning. Also, that it burn oil or gas, or both, under wide conditions of excess air with a completely stable flame. The installation of an auxilary fuel burner and a CO port in the primary furnace is shown in Fig. 4.

Figure 5 shows the B&W center-fired gas and oil burner, which is stable under wide ranges of excess air. It also allows the gas element to be withdrawn through an air aspirated sleeve. The oil gun and gas lighter are also removable through air aspirated sleeves. The air register and the impeller are the only parts of the burner that cannot be repaired during operation.

The water seal tank design is such that the CO gas comes in the side and goes out the top, instead of in the top and out the side. And the dampers are placed on the outlet instead of the inlet. Placing the dampers on the outlet makes the seal tank a knockout pot for refractory or other material from lined ducts that might damage the damper.

Primary Furnace Is a Good Mixing Device

From an operating standpoint, the primary furnace is a good carburetor for the mixing of air, fuel oil, refinery gas and CO-bearing gas. The author believes that tangential firing in a cylindrical furnace is a stride in the right direction. Our tests confirmed this on our East Chicago CO boiler.

Combustion conditions in the primary furnace were studied using a water cooled probe. Furnace pressures, temperatures and furnace gas analyses were made at the two auxiliary firing levels and across the furnace. Temperatures were determined with a high velocity thermocouple.

In the tests, all the CO was completely burned in the primary furnace. We noted that the distribution of auxiliary fuel and air to each burner was not important because the cyclonic action of the CO-bearing gas provided excellent mixing.

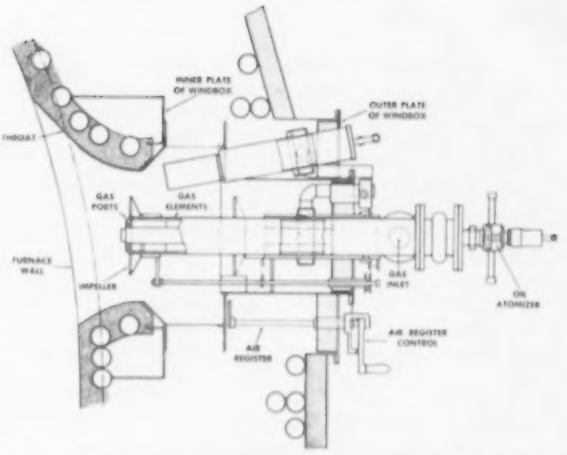


Fig. 5—**B&W CENTER-FIRED BURNERS** are designed to permit withdrawing the gas element through an air-aspirated sleeve

Table 1—Test Data for East Chicago CO Boiler

Test No.		1	2
Boiler Feedwater			
Quantity, M lb/hr		284.075	259.270
Temperature, °F		240	241
Steam at S.H. Outlet			
Quantity, M lb/hr		264.175	245.010
Pressure, psig		570	590
Temperature, °F		695	690
Auxiliary Fuel, Million Btu/hr		259.105	230.800
CO Gas, " " "		95.570	90.870
Total " " "		354.675	321.670
Total Heat Absorbed, Million Btu/hr		307.490	280.920
Efficiency = Total Heat Absorbed / Total Heat Released, %		86.6	87.5
Boiler Exit Dry Flue Gas Analysis			
Carbon dioxide	Vol. %	13.3	12.6
Oxygen	Vol. %	3.4	3.8
Carbon monoxide	Vol. %	0.0	0.0
Temperature, °F		520	486
CO Bearing Gas Analysis			
Carbon dioxide	Vol. %	9.3	7.7
Carbon monoxide	Vol. %	4.9	4.7
Oxygen	Vol. %	2.1	1.9
Nitrogen	Vol. %	65.9	64.8
Water vapor	Vol. %	17.8	21.0
Total		100.0	100.0
Temperature, °F		495	505

As an illustration of good mixing, with the fuel oil and gas delivered to the auxiliary burners at a constant rate by automatic flow control, the fuel oil or gas, or both, can be shut off from one burner while using the same quantity of auxiliary air without any apparent change in boiler operation. This means that some of the burners can operate with a shortage of air and others with an excess of air, provided the total air-fuel ratio is correct.

This circular CO boiler has a tougher job than the other CO boilers built to date. In it, CO bearing gas enters at approximately 500°F. In other CO boilers the entering gas temperature is approximately 1000°F. With the low temperature of the CO gas, more auxiliary fuel must be burned or a lower furnace temperature results. The boiler has already operated over a rather wide range of ratings and furnace temperature, indicating good design features.

Some typical performance test data are shown in Table

1. Inasmuch as the CO-bearing gas temperature is substantially the same as the boiler exit temperature, a large quantity of inert gas passes through the furnace on a "free-ride" basis. The waste heat recovered is substantially all from the burning of the CO. When there is enough surplus oxygen in the CO gas to burn all the CO to CO_2, the efficiency of the CO gas burning is 100%. During these tests the tabulated conditions existed.

The auxiliary fuel is burned at an efficiency of approximately 80%. The percent of heat absorbed from the heat of combustion of CO is approximately 31%. The heat absorbed from auxiliary fuel was approximately 69%. When 31% of the total heat is absorbed at 100% efficiency, and 69% of the heat is absorbed at 80% efficiency, the overall efficiency is approximately 87%.

Efficiencies shown in Table 1 are calculated from the heat absorbed by the boiler, the heat in the auxiliary fuel, and the heat of combustion of the CO. The efficiencies are high when calculated on the above basis, but it does not seem just to penalize the boiler for the heat input of the inert gas that merely passes through the boiler on a "free-ride" basis and which neither gives up nor absorbs heat. Using the conventional method of calculating boiler efficiency on the basis of the total heat absorbed and the total heat input, the efficiency of this type of boiler will depend upon the total heat put in, including the sensible heat of the inert gas. The efficiency calculated on this basis is quite meaningless.

In actual operation, the expected performance is obtained only when the boiler surface is externally clean. Immediately after soot blowing, the exit flue gas temperature meets expected performance. The exit flue gas temperature on the average is approximately 50° higher than expected performance. It is suggested that boiler manufacturers of future CO boilers lower heat transfer rates when calculating surface requirements for CO boilers. The nature of the catalyst dust is apparently different from the coal-burning boiler dust and it is evidently necessary to use additional surface.

Fuel Savings

The fuel savings effected by a CO boiler are a function of the cost of the auxiliary fuel burned and the value of the steam produced. In making this evaluation, it must be understood that the auxiliary fuel burned under a CO boiler is not burned as efficiently as it could be in a well-designed conventional boiler. This loss of fuel must be debited against the savings effected by the burning of the CO. Assuming that the auxiliary requirements of the CO boiler are the same as a conventional pressure-fired boiler, the fuel savings of the circular CO boiler as installed amounts to approximately $1,000 day with a fuel price of 45 cents per million Btu.

Air Pollution Reduction

A CO boiler that burns all the CO to CO_2 not only saves fuel, but eliminates pollution of the air with CO. In the normal operation of a Fluid Unit the only combustible leaving the regenerator is the CO, but during times of abnormal conditions there is a likelihood of other combustibles being emitted to the atmosphere. Under such conditions, the CO boiler burns these other combustibles, rendering them into normal products of combustion. It can be said without contradiction that a CO boiler on a Fluid Unit reduces air pollution.

Conclusions

Judging from operating experience to date, the first large size circular CO boiler in operation is a success. It has many advantages that other CO boilers do not have. Its design opens up a new field in pressurized furnace boiler construction units that can be readily adapted to conventional pressurized furnace boilers. Our most difficult problem in the building of the circular boiler was convincing the boiler manufacturers that it could be built, and would cost no more than a conventional CO boiler. The East Chicago CO boiler has shown that a circular boiler costs less than previously built CO boilers of the same capacity.

The general trend in boiler design is to operate the furnace under pressure and eliminate the use of induced draft fans. The end results are: (1) a lower horsepower requirement for supplying the air to the furnace and removing the products of combustion, and (2) increased efficiency resulting from elimination of air infiltration to the setting. The cost of maintenance is less as the induced draft fans are eliminated. The circular boiler furnace lends itself best to pressurization. It should become a standard design for pressurized CO boilers and conventional boilers.

In conclusion, Sinclair Refining Co. appreciates the opportunity to pioneer the circular boiler design and wishes to congratulate The Babcock & Wilcox Co. for its courage in designing, building, and guaranteeing the successful operation of the circular boiler.

ACKNOWLEDGEMENT

The author wishes to thank the following engineers for their assistance in the original design, drawings, photographs, construction and operation of the CO boiler and offsite work:

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REFERENCES

"Cracking Unit a Source of Heat?", O. F. Campbell and N. E. Pennels, PETROLEUM PROCESSING, Vol. 9, No. 3, March 1954, pp. 352-358.

"Cat Cracker CO Boiler and Fluidized Bed Steam Superheater," O. F. Campbell and N. E. Pennels, *Petroleum Engineer*, Vol. 26, No. 6, June 1954, pp. C34-42.

"CO Boiler, Fluidized Bed-Steam Superheater—Feature F.C.C. Plant," O. F. Campbll and N. E. Pennels, *Oil & Gas Journal*, Vol. 52, No. 42, pp. 132-136, 176-179.

"CO Boiler and Fluidized Bed-Steam Superheater on Sinclair Refining Company's New Fluid Unit at the Houston Refinery," O. F. Campbell and N. E. Pennels, Vol. 77 of August 1955 ASME *Transactions*, p. 927.

Meet the Author

Mr. Pennels

N. E. Pennels, who has been assistant combustion engineer with the Sinclair Refining Co. since 1952, is a 1947 graduate of Michigan State University in chemical engineering. Mr. Pennels began as a trainee in the research and development dept. of Sinclair. He spent four years as an engineer in the technical service department of Sinclair's Wyoming refinery, and one year as a project engineer in the expansion of Sinclair's Houston, Texas, refinery.

PETROLEUM PROCESSING brought a tape recorder to the last regional meeting of the Western Petroleum Refiners Ass'n in El Dorado, Ark., and came away with enough valuable tips to provide a series of articles on solving processing problems. Source of information is the panel of authorities that took on all questions at an all-day question-and-answer session during the meeting. This is the last part of the series. For list of panel members, see box on p. 89.

Eleven technologists and a recorder help you solve

Treating and Other Problems

? What methods are used to prevent or reduce caustic carry-over from caustic scrubbers or settling drums when this caustic is used for the removal of sulfide, mercaptans and acid oils from gasolines?

Buchanan

Buchanan: From the wording of the question I suppose they refer to a conventional hook-up—that is, a pre-wash for hydrogen sulfide removal, followed by a mercaptan scrubber. We've had some trouble ourselves with it, and have since whipped it by paying close attention to the Baumé gravity. We have knock-out drums after the pre-wash and after the scrubber. We carry 8-10° Bé gravity on the pre-wash for simple hydrogen sulfide removal and dump it on percent spent. And that's ample protection for mercaptan scrubbers. We have finally arrived at 22° Bé as the critical gravity for the mercaptan scrubber to prevent carry-over. This is in thermal gasoline service. And we dumped this on acid oil content. Somewhere around 25° Bé we get into serious trouble with carry-over from that second scrubber.

? What do you do with your caustic?

Buchanan: We dump the 10° Bé from the pre-wash. The theory on the other is to use it in the pre-wash. That is, to dilute it out to 10° Bé and use it. Everybody says the theory's good, but very few people do it that way. We have, on occasions, done it. But right now, I think we're not. We're just dumping it. By the way, Harry, I believe you mentioned that you actually had an octane increase by going to 40° Bé caustic on a cat gasoline scrubber, and that you were able to do it by having a pre-wash.

Wheeler: Yes sir, that is correct.

Buchanan: The second scrubber will contain a very small amount of sodium sulfide, just a trace. That's the purpose of pre-wash, to protect the second scrubber. If you do permit a carry-over from the first settler, as your second scrubber begins to neutralize it will throw off mercaptans and acid oils, or both, into your gasoline. But, if you protect it, you can dump on acid oil content from the second scrubber. We finally lined out at about 30% acid oils as the dump point. Of course, you have to find that point by running an inhibitor susceptibility, or stability, test on the gasoline. If we protect the caustic in the second scrubber against sodium sulfide, we are able to dilute it and use it for H_2S scrubbing.

? What methods have been successfully used to prevent excess sulfuric acid sludge carry-over into the caustic wash in kerosine treating?

Comment (Rippie-Electric Process Co.): One way this problem can be solved is to give the kerosine, or the stocks to be treated, a water or dilute caustic wash before the acid treat. This will remove the materials that form soap with the sulfuric acid and, as a result, prevent carry-over.

Wheeler

Wheeler: Mr. Forter (Cities Service) says they doctor-treat their kerosine before acid treating. Then following acid treating, they filter it through clay. No problems with sludge carry-over —but their kerosine is so dry it is a non-conductor and presents quite a problem in barge loading because of static electricity.

Rippie: Messrs. Henderson, Ridgeway and Ayers of the Pure Oil Co. published a paper that appears on page 114 of the March 28, 1940, issue of the *Oil & Gas Journal*. This paper was on the analysis of water soluble, volatile organic acids in distillate oils. They neutralized the caustic with phosphoric acid, removed the oil soluble layer with sweet naphtha, and water washed and distilled all aqueous fractions in all-glass equipment. They titrated the distillate with standard sodium hydroxide and determined the equivalent of organic soluble acids in the spent caustic solution. The procedure should be more widely used in oil treating.

? Has anyone had experience with a mist arrestor on the top of his Girbitol regenerator to prevent a mist solution from being carried overhead with the acid gases?

Fuchs

Fuchs: I believe the question refers to a "York Blanket." We do not use a York Blanket on our Girbitol regenerator, but we have one in our Ultraformer recycle gas separator. It is Monel, and we find it effective in knocking back the liquid entrainment from the recycle gas. The answer to this question might be that a mist arrestor would be a good idea for preventing liquid carry-over. On caustic regenerators using steam and open to the atmosphere we use a commercial, cyclone-type, liquid knock-back, mist eliminator on top of the exhaust line. We find it effective in keeping entrained caustic out of the atmosphere.

? Alexander—Pan Am: We understand Cities Service is using a Unisol extraction unit to extract mercaptans from cat gasoline, and we are wondering what octane increase they get by that extraction? That is, your leaded octane increase?

Wheeler: Mr. Byrd, of Cities Service, points out that they get about a two octane number increase by Unisol extraction. On this point that Lloyd Buchanan was making, we feel that a 40° Bé wash gets up between 0.3 and 0.4 octane increase on our cat gasoline.

Rippie: I would like to review a question that was asked at the session last year. Now, just for a matter of review and consideration of refiners in the octane race and concerned with quality improvement, I would like to review two papers prepared by the manufacturers of tetraethyl lead. Probably without a doubt, the most famous paper ever published on economics of tetraethyl lead was the one Ethyl Corp. read at the American Petroleum Institute, Refining Division meeting in Cleveland in May, 1950. They gave a set of curves on the effect of various sulfur compounds in gasoline. To the best of our knowledge, this is the only curve ever published in the petroleum industry in which the dollar-and-cents costs were actually tagged.

Now, I just want to use one illustration on a cat cracked gasoline with 0.003% mercaptan sulfur inhibitor sweetened. Ethyl Corp. reported that 15% of the annual tetraethyl bill is lost by that 0.003% mercaptan sulfur being converted to 0.003% disulfide sulfur. In other words, a million-dollar tetraethyl lead bill at a refinery would be depreciated $150,000, according to the Ethyl report.

Within the last few months, the Kopper Co. published a new bulletin showing the same effect that 0.003% mercaptan sulfur in catalytic cracked gasoline, inhibitor sweetened, produces 1.2 peroxide numbers. You will find this on page 13 of their bulletin, No. C-5-179. Now, I would like to tie that into a most rigorous paper that the Du Pont Co. published in *Industrial & Engineering Chemistry* in March, 1951. You will find, on page 666, a most alarming depreciation of octane by 1.2 peroxide numbers. They show a loss of about 10 research octane by 1 peroxide number. And, if you add that together with what the Ethyl people have calculated, you will see that it is possible, and pays in the octane race, with all this cat reforming, to take out mercaptan sulfur before the final residual conversion to disulfide sulfur.

Wheeler: Thank you, Dr. Rippie. That's a lot of money in anybody's language.

Ferguson

? Ferguson: I want to throw in a question here, and I want to get Dr. Walter to elaborate on it . . . What about a filter, or filtering material, that would prevent catalyst in a cat poly unit from migrating from the reaction chamber during a C_3 tetramer operation. It seems that several different filter materials have been tried in one particular operation, and the catalyst still showed up in the reboiler. Can Dr. Walter, of Universal Oil Products Co., elaborate a little on that situation?

Walter

Walter: It sounds, from all indications, as though maybe the feed is a little too wet for tetramer operation. We do get into trouble with filters when the feed is on the wet side. You can't stop it as long as the feed is kept wet. We normally use some sort of a fiber glass insulation for the filtering, as you probably know. That will normally work all right, unless you get the feed too wet and start carrying phosphoric acid through the filter. If this happens you'll get phosphoric acid and, as a result, corrosion in the reboiler of the depropanizer. So I think, fundamentally, the answer would be: dry the feed.

Where this Information Came From

THE all-day question-and-answer session is a popular part of the WPRA's annual regional meeting.

The 10-man panel replies to prepared questions, then answers questions from the floor.

The group of five refinery men and five engineering men was directed by Harry K. Wheeler, Pan-Am Southern Corp., El Dorado, Ark.

The refiners were: N. S. Banta, Pure Oil Co., Nederland, Tex.; E. A. Heike, Premier Oil Refining Co., Ft. Worth, Tex.; L. K. Buchanan, Bell Oil & Gas Co., Armore, Okla.; M. S. Moody, Lion Oil Co., El Dorado; and O. A. Fuchs, Pan-Am Southern Corp., El Dorado.

The engineering panel: R. R. Maddocks, Blaw-Knox Engrg. Co., Pittsburgh, Pa.; J. S. Clarke, Esso Research & Engrg. Co., Linden, N. J.; D. F. Ferguson, The Refinery Engrg. Co., Tulsa, Okla.; J. F. Walter, Universal Oil Products Co., Des Plaines, Ill.; and D. E. Womeldorph, Houdry Process Corp., Philadelphia, Pa.

? What is a practical method of controlling the pH of steam condensate to prevent corrosion from CO_2?

Ferguson: Mr. McCumber says he has available a filming amine inhibitor that eliminates the problem of the pH of the steam condensate. The filming inhibitor prevents corrosion from CO_2. Would you like to elaborate on that, Mr. McCumber?

McCumber: In refineries, and other "complex" plants where the utilities take off power first with turbine generators, etc., there are definitely very critical limits to what can be put into the steam, and also on where it is put, without running into superheater or turbine blade fouling, etc.

The volatile amines that have been used occasionally to control steam-line corrosion are introduced into the boiler where they volatilize and pass over with the steam and neutralize the effect of CO_2 and other corrosive contaminants by elevating the pH of the condensate. Such an amine is costly where the condensate return is proportionately low, and, if the percentage of condensate return is high, care must be used to prevent excess accumulations in the boilers. Such an amine is only partially effective against oxygen and some other gases, etc. The amine treatments available up to now have been patented, and practically all suppliers have been limited to a relatively few materials controlled by license.

We now have available a filming type amine that is not controlled by the owners of the original patents. It is a filming type amine that is easy to handle and control, and which can be put into the steam lines at any point, mechanically, under sufficient pressure to atomize it. This amine can be put into the extraction steam going into process lines where it will distribute uniformly, and form an adherent and continuous film of controlled thickness without any possibility of clogging traps, etc.

Because this amine does not attempt to absorb the CO_2 or oxygen, its effect on the pH is not a factor and not an indicator. In order to quickly establish protection in existing systems, 20 ppm to 30 ppm dosages are recommended. This should be fed continuously during all normal steaming periods.

After the protective film is established the feed rate can be reduced to as low as 5 ppm in many situations. Once the system is satisfied in regards to this film, the amount that is fed can be regulated to the minimum amount required to replace the film if it becomes damaged. We have never experienced any appreciable loss of heat transfer efficiency.

The film passivates the steam and condensate confining metal surface so that it is protected regardless of the residual CO_2 or oxygen present, the pH, or the rate of flow of the return condensate.

Actually, in the different processes and uses of steam oxygen other contaminants are apt to be picked up along the line in widely varying amounts, especially in vacuum lines. One of the troubles with the use of amines to date has been the great application difficulty—getting them to the place where they are needed most.

Even with the normal fluctuations of operations, it is very hard to get the volatile-type amine to distribute itself equitably throughout a plant. It will take some sections of plant return lines a long time to get balanced out.

In other words, the volatile amines because of their nature are bound to be carried to the points of greatest activity, whereas it is pretty obvious that the greatest corrosion is probably taking place at the points where the steam demand and the flow of the condensate returns are the lowest. The new filming-type amine that passivates the metal surfaces overcomes these objections and is economical and effective.

Wheeler: Mr. Forter of Cities Service points out that they have used these filming types of amines and injected them into their process steam headers. Based on the condensate returned, and the demineralizer operation, there has been considerable reduction in corrosion in the system.

Turnbull (Cities Service Refining): Mr. Forter might not be aware of this, but you have to watch bucket-type steam traps. Watch for deposits. When they build up a coating, you have to go in and clean them.

? Getting around to utilities—has anyone had experience with the chemical treatment of a redwood cooling tower for the prevention of fungus infestation? What are the economics of this treatment?

McCumber (Wright Chemical Corp.): The question asks what are the economics of this treatment? I think that is probably the crux of the whole question. We do have materials that we feel will work on this problem. To my knowledge, however, there is no treatment known that will stop fungus in wood after it has gone beyond what can best be termed "the immediate surface" of the wood.

Wood that is already deeply infested should be replaced, preferably with pre-treated new wood. Once this

has been done, the system water can then be treated to prevent re-infestation. This can be done at a cost that is justified by the results and economies obtained. We offer treatments that will more or less "plate" the wood in the same way that filming-type corrosion inhibitors "plate" the metal surfaces to control corrosion.

? Wheeler: Is it necessary to have any special equipment to plate wood, or do you just add these materials to the water?

McCumber: The treatments can be added economically to the water, direct, and in batches periodically. None of the materials we offer will accelerate corrosion. They will aid materially in the control of other forms of biofouling.

Wheeler: Mr. Wright, of Pan-Am, feels that this might be quite a tough problem. He points out that you start out with a fungus growth and you kill the fungus. Then you get acid, and then you've got to neutralize the acid. Then when you neutralize the acid you get scale, and then you do something about the scale and you've got fungus back again. I'm sure your materials, Mr. McCumber, do not act that way, is that right?

McCumber. The materials we offer are approximately "neutral" and they can be used with any of the commonly known effective cooling water conditioning materials. They will have little or no effect on the pH.

? Wheeler: Mr. Wright of Pan-Am asks: Have the amines coated the reboiler tubes enough to reduce heat transfer? This sounds like one of these cooling tower deals, doesn't it?

Comment—Johnson, American Liberty: We have been using this amine-type inhibitor for several years. It costs about $250 a month, and it has reduced our maintenance many times in leaks and other problems.

Break (Pan-Am Southern): These film-type inhibitors probably contribute to keeping the tubes clean and could very well increase your heat transfer rather than decrease it.

? Now, for some other questions—is there any satisfactory method of obtaining a true average temperature of refinery products in storage?

Fuchs: A satisfactory method of taking a true average temperature of all refinery products in storage is hard to find. There are all types of storage. We have one application of a resistance-type thermometer in a pressure tank for tar. The various resistance circuits are at different tank levels, and are connected to a push-button selector switch.

By knowing the tank level and pushing the proper button, we obtain the average temperature of the oil in the tank. We installed this because we ship and bill out of this tank.

For run-down tanks, we do not do anything special. Temperatures are taken with the ordinary immersion-type tank thermometer. I believe that one advance made in this field of average tank temperatures is the installation of mixers in tanks. We have mixers in our crude tanks and in our blend tanks. That probably represents as much progress in obtaining average tank temperatures as anything done in recent years.

Wheeler: Mr. Combs points out that Weston has a bulletin on resistance-type thermometers for tankage, to give you average temperature. That's the instrument we have.

? What methods are used to obtain accurate proportioning of propane and butane when loading blends of these products into tank cars or trucks?

Buchanan: Well, as stated this morning, we don't flow-mix our butane and propane. However, in the past we have shipped a mix. We have made a mix directly off the plant. That's one way to handle it, to store mix. But, if you have to ship different proportions, the ideal practice, of course, is to have meters and in-line mixing on the way to the tank car. From a practical standpoint, I see nothing wrong with presetting the dip gage on the tank car, or truck, for the percentage of butane. Of course, you have to have an outage in a car anyway—in an LPG car, nine to ten-inch outage You could load through fill lines with butane first, up to a present gage, and fill it with propane. I don't think you would have any trouble testing it; it should mix in the car, and it would certainly mix before it got to the customer. I can't say that we have actually done that, but I see no reason why you couldn't do it.

? Banta: I would like to ask if there are any people here who have, in their plants, tubular-type vertical cat poly reactors? I would like to inquire what problems there might be in cleaning those reactors, and if diluting the catalyst has been considered? I'm assuming phosphoric acid-type catalyst is being used. Has diluting the catalyst with charcoal been considered?

Wheeler: Mr. Curran, with American Oil, points out that they do have the tubular reactors, and they have considered adding an inert material primarily on the basis of increasing the catalyst life. They may have had trouble in the past in removing the catalyst because of water getting into the tubes, but apparently they can turn the unit around in a pretty short time.

Comment—Maddock, Ohio Oil: We have the tubular reactors. They run to about 45 psi pressure drop, catalyst life between 100 to 150, and on that basis we haven't had any trouble removing the phosphoric acid catalyst from the tube.

Banta: I might comment that our catalyst life is in the neighborhood of 150 to 200. We press them pretty hard. The longer you run them, the harder the trouble cleaning, apparently from polymer-like material. Our method of cleaning is to drill from the top. Actually, we utilize the kerosine diluents to facilitate the cleaning and drilling operations. The time it takes to clean is not too satisfactory.

Chemistry of Inhibitor Sweetening

Effects of variations in olefins and caustic

By R. H. ROSENWALD
Universal Oil Products Co.

In an earlier article in* PETROLEUM PROCESSING, *the author proposed a mechanism to explain the inhibitor sweetening process for gasoline treatment. His original data were based on reactions with only one olefin—cyclohexene.*

This article reports his latest work in this field, and presents the results of subsequent experiments with three other olefins—1-octene, methyl-1, 3-pentadiene, and styrene. The new data seem to verify the earlier explanation of the mechanism of inhibitor sweetening.

ONE METHOD of sweetening sour gasoline (removal of the mercaptans) is by inhibitor sweetening. This involves storing the caustic scrubbed fuel for short periods of time in the presence of air and a substituted phenylene diamine type inhibitor, such as Universal Oil Products Co.'s No. 5 Inhibitor. The end result is an air oxidation of the mercaptans in a cracked gasoline, using the inhibitor as a catalytis.

The process offers a simple and economic method of removing the undesirable mercaptans from motor and aviation fuel. As a result, many refineries have adopted this method. But the explanation of the mechanism involved in the treatment is not simple.

The Basic Reaction

The reactions involved in inhibitor sweetening have been identified by studying the oxidation of an olefin solution of mercaptan, both in the presence and the absence of caustic and UOP No. 5 Inhibitor. The consumption of mercaptan in these oxidations is the result of two consecutive reactions as follows:

Step 1

$$C{=}C + RSH + O_2 \rightarrow \underset{\underset{S}{|}\ \underset{R}{|}}{C{-}C{-}OOH}$$

Step 2

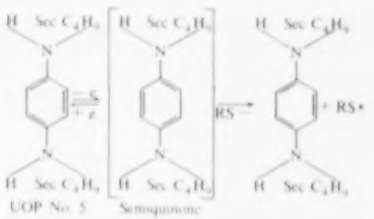
$$\underset{\underset{S}{|}\ \underset{R}{|}}{C{-}C{-}OOH} + 2RSH \rightarrow \underset{\underset{S}{|}\ \underset{R}{|}}{C{-}COH} + RSSR + H_2O$$

The overall reaction is thus:

$$C{=}C + O_2 + 3RSH \rightarrow \underset{\underset{S}{|}\ \underset{R}{|}}{C{-}C{-}OH} + RSSR + H_2O$$

The presence of UOP No. 5 Inhibitor (N,N'-di-sec-butyl-p-phenyl-diamine) ties these two steps together and gives a re-occurring cycle with mercaptan consumption.

Reactions are induced by the No. 5 Inhibitor taking part in an alternating oxidation-reduction system, which is summarized below:



The semiquinone (or Wurster's salt) is reduced by the mercaptan to give the mercapto-free radical RS·, in which the unshared single electron is signified by the dot. The following sequence of reactions, or variations

* "Chemistry of Inhibitor Sweetening," by R. H. Rosenwald, PETROLEUM PROCESSING, Vol. 6, No. 9, pp. 969-973, Sept., 1951.

Table 1—Inhibitor Sweetening of n-Butyl Mercaptan in Olefins at 30°C

Run	1[a]	2	3	4	5	6	7	8	9[a]	10	11	12	13	14
Olefin	1-Octene				Methylpentadiene				Styrene					
Charge, wt. in grams:														
Olefin	10.758	11.079	10.888	10.995	10.640	10.995	10.922	10.942	12.723	10.422	12.914	11.339	11.339	12.355
n-Butyl mercaptan	0.550	0.5735	0.538	0.580	0.556	0.563	0.542	0.545	0.0385	0.5375	0.554	0.572	0.552	0.559
UOP No.5 Inhibitor	—	—	0.0597	0.0521	—	0.041	—	0.049	—	—	0.037	—	0.030	0.0495
Caustic	—	—	—	0.0815[b]	—	—	0.097[b]	0.082[b]	—	—	—	0.044[c]	0.038[c]	0.092[b]
Oxidation data:														
Duration of run, hrs	47	48	52	**14**	73	24.5	26	**4.5**	31	22	49	93	**4**	**4**
Rate of oxygen absorption, Moles O_2 mole RSH/hr	0.01	0	?	0.1	low ca.	0.05	—	0.16	0.09	slow	0.03	0.0015	0.18	0.18
Total absorption, moles O_2/mol RSH	0.36	0	0.24	0.47	0.07	0.76	0.13	0.48	2.8	0.01	0.50	0.08	0.37	0.47
O_2 absorbed as peroxide, %	0	—	0	5	0	25	0	33	0	—	—	—	—	0
Mercaptan:														
% Remaining	55	—	70	**0**	96	16	45	**0**	91	—	44	71	**0.3**	**0**
% Conversion to disulfide	6	—	6	59	—	4.5	53	51	—	—	9	24	60	53
Moles O_2 absorbed/mole RSH consumed	0.80	—	0.79	0.47	—	0.90	0.24	0.48	—	—	1.1	0.27	0.37	0.47
% RSH consumed to disulfide	13	—	20	59	—	5	97	51	—	—	15	82	60	53

(*a*) Run made in absence of U.O.P. No. 7 Inhibitor.
(*b*) 20 Weight per cent solution of sodium hydroxide.
(*c*) Refinery caustic.

Table 2—Inhibitor Sweetening of t-Butyl Mercaptan in Olefins at 30°C.

Run	15	16	17	18	19	20
Olefin	Styrene			Methylpentadiene		
Charge, weight in grams:						
Olefin	13.238	13.181	13.228	10.282	10.858	11.046
t-Butyl mercaptan	0.4935	0.520	0.495	0.473	0.468	0.529
UOP No. 5 Inhibitor	—	0.0437	0.0661	—	0.0465	0.0455
Caustic	—	—	0.0784[a]	—	—	0.101[a]
Oxidation data:						
Duration of run, hrs.	94	27	12	64	48	23
Rate of oxygen absorption, moles O_2/mole RSH/hr.	low	?	—	0	0.02	0.05
Total absorption, moles O_2/mole RSH	0.004	0.61	0.58	0	0.68	0.58
O_2 absorbed as peroxide, %	—	0	0	—	0	28
Mercaptan:						
% Remaining	85	40	42	—	30	12
% Conversion to disulfide	—	2	2	—	0.4	3
Moles O_2 absorbed/mole RSH consumed	—	1.01	0.99	—	0.97	0.96
% RSH consumed to disulfide	—	3.5	3	—	0.5	4

(*a*) 20 weight per cent solution of sodium hydroxide.

thereof, is initiated by this radical to complete step 1.

$$C=C + RS\cdot \rightarrow C(S,R)-C\cdot$$

$$C(S,R)-C\cdot + O_2 \rightarrow C(S,R)-COO\cdot$$

$$C(S,R)-COO\cdot + \text{No. 5} \rightarrow C(S,R)-COOO + \text{semiquinone}$$

The Importance of Testing Other Olefins

In the multi-component system encountered in inhibitor sweetening, numerous reactions are theoretically possible. The reactions actually observed are determined by the comparatively greater rates of certain reactions to the exclusion of other reactions that are slower. This fact is especially pertinent in the sequence of steps involving chains, because minor changes in conditions can favor or instigate certain competitive reactions, and thereby accelerate or retard the rate of mercaptan consumption.

The nature of the olefin and the caustic are two factors to be considered in the explanation of inhibitor sweetening. The nature of the olefin is of interest, particularly, because the proposed scheme of reaction was presented with data obtained exclusively with cyclohexene. This paper considers the oxidation of mercaptans in three other olefins, with the object of verifying the inhibitor sweetening reactions as originally proposed.

The three olefins employed are 1-octene; methyl-1,3-pentadiene; and styrene. These are examples, respectively, of a straight-chain olefin, a conjugated diene and a reactive monolefin.

For the runs reported in Tables 1, 2 and 3, these olefins were protected against rampant oxidation by the addition of about 0.01 gram of UOP No. 7 Inhibitor (2,6-di-t-butyl-4-methylphenol). This antioxidant does not alter the course of the mercaptan oxidation. It is used merely to minimize changes in the olefin during storage and experimentation.

Using the procedure described in the earlier article*, the oxidation of n-butyl mercaptan in three olefins and t-butyl mercaptan in two olefins was investigated. The data obtained are summarized in Tables 1 and 2.

These Are the Results

In the absence of UOP No. 7 Inhibitor (Run 1), a slow reaction occurred between n-butyl mercaptan and 1-octene. In the presence of this antioxidant (Run 2), no oxygen absorption was observed. The addition of UOP No. 5 Inhibitor (Run 3) initiated an appreciable but slow oxidation of mercaptan, as previously reported, with cyclohexene. The combination of UOP No. 5 Inhibitor and caustic (Run 4) gave rapid consumption of mercaptan and large amount of disulfide formation. These results, in general, indicate that reactions typical of inhibitor sweetening do take place with 1-octene.

However, no noticeable reaction ensued with n-butyl mercaptan in methyl-1,3-pentadiene (in the presence of UOP No. 7 Inhibitor) as recorded in Run 5. The addition of UOP No. 5 Inhibitor (Run 6) promoted an appreciable reaction, which was characterized by considerable oxygen absorption, low disulfide formation and high peroxide formation. Under these conditions UOP No. 5 Inhibitor prompts the first step of the reaction sequence (Step A), but is not able to complete Step B. With methyl-pentadiene the high olefin reactivity not only favors this reaction, but the peroxide formed is sufficiently stable so that detectable peroxides are formed. The oxidation in the presence of caustic (Run 7) was incomplete and the reaction was solely that of disulfide formation according to the equation:

$$4RS + O_2 \rightarrow 2RSSR + 2H_2O$$

It is of interest to note that mercapto free radicals cannot be an intermediate in this latter oxidation; the highly reactive diene would immediately accept any free radicals, if formed, to the exclusion of disulfide formation.

The combined effect of UOP No. 5 Inhibitor and caustic (Run 8) gave consumption of mercaptan in the short time of less than 4.5 hours. Of the oxygen absorbed (0.48 moles/mole RSH), 33% was found as detectable peroxides. It appears that the greater portion of the excess oxygen required (above 0.33) mole/mole RSH) is peroxidic. The reason is believed to involve the reactivity and peculiarities of the olefin.

In Run 9, a solution of n-butyl mercaptan in styrene (in the absence of UOP No. 7 Inhibitor) gave considerable absorption of oxygen. However, the mercaptan is not brought into this reaction for 91% was recovered after 31 hours. In the presence of UOP No. 7 Inhibitor (Run 10), no oxidation occurred. The results from Run 9 indicate that the hydroperoxide free radical from styrene does not react with the mercaptan, as it does with 1-octene. Instead, the high reactivity of the styrene double bond successfully competes with the mercaptan, and a dialkyl is formed.

$$R_1OO\cdot + RSH \rightarrow R_1OOH + RS\cdot$$
$$R_1OO\cdot + C=C \rightarrow R_1OO-C-C\cdot$$

UOP No. 7 Inhibitor can intervene in the chain by reaction with the hydroperoxide free radical and thereby effect stabilization.

The effect of UOP No. 5 Inhibitor (Run 11) was to promote a slow but noticeable reaction. In Run 13, the effect of refinery caustic was essentially to catalyze disulfide formation. The combined effect of caustic and UOP No. 5 Inhibitor (Runs 13 and 14) will give typical inhibitor sweetening at a rapid rate.

*See footnote, p. 91

Table 3—Inhibitor Sweetening of Butyl Mercaptan at 30°C, Effect of Variation of Caustic

Run	21	22	23	24	25	26	27	28	29	30	31
Olefin	Cyclohexene				Methyl pentadiene	Styrene	Cyclohexene				Methyl pentadiene
Charge, weight in grams:											
Olefin	11.825	12.342	11.979	12.244	12.012	13.529	12.216	12.155	12.587	12.232	10.876
Butyl mercaptan	0.561	0.557	0.5075	0.5825	0.6090	0.566	0.7355	0.546	0.625	0.558	0.536
Configuration	n	n	n	n	n	n	n	n	sec	t	t
UOP No. 5 Inhibitor	0.0375	0.0440	0.0422	0.0440	0.0513	0.0575	0.0514	—	0.0493	0.0476	0.0570
Additive	0.0895[a]	0.0494[a]	0.0733[c]	0.0515[d]	0.0615[d]	0.0690[d]	1.209[d]	1.077[d]	0.0735[d]	0.0694[d]	0.075[d]
Oxidation data:											
Duration of run, hrs	23	25	22.5	23	5.5	4.0	24	23	24	24	25.5
Rate of oxygen absorption, moles O_2/mole RSH/hr	0.36	0.02	0.32	0.2	0.3	0.35	ca. 0.18	0.03	0.07	—	0.12
Total absorption, moles O_2 mole RSH	0.70	0.285	0.56	0.37	0.28[e]	0.35	0.36	0.38	0.48	0.30	0.92
O_2 absorbed as Peroxide, %	0	0	2	0	0	0.6	—	—	0	0	23
Mercaptan:											
% Remaining	6.4	33	4.5	0	0	0	0	0.3	5	73	0
% Conversion to disulfide	30	43	45	66.5	65	62	80	95	56	3	10
Moles O_2 absorbed/mol, RSH consumed	0.74	0.41	0.59	0.37	0.28[e]	0.35	0.36	0.38	0.51	1.09	0.92
% RSH consumed to disulfide	32	65	47	66.5	65	62	80	95	58.5	12	10

a) Aqueous solution of ammonia (9 wt. %).
b) Benzyltrimethyl ammonium hydroxide.
c) Piperidine.
d) Methanol caustic: 1 part sodium hydroxide, 3 part water, 2 parts methanol.
e) This value low due to oxidation prior to connection of reaction flask to assembly.

From a practical point of view, it is desirable to achieve mercaptan consumption with minimum oxygen absorption and maximum disulfide formation. Oxygen absorption in excess leads to formation of peroxides; a high conversion to disulfides is an indication that complete reductive decomposition of the peroxidic intermediate has taken place. On this basis, refinery caustic (Run 13) gave slightly superior results.

The reactions involved in the oxidation of n-butyl mercaptan in presence of caustic and UOP No. 5 Inhibitor are similar with all four olefins investigated. Inhibitor sweetening does not require any particular type of olefin but does proceed by following a definite pattern with various olefins.

The difficulty in sweetening mixtures containing t-butyl mercaptan was considered in the earlier paper.* The question arises whether this difficulty can be alleviated by the use of a more reactive olefin. Consequently, an attempt was made to oxidize t-butyl mercaptan in styrene and in methyl-1,3-pentadiene (Table 2, Runs 15 through 20).

The mercaptan in olefin (Runs 15 and 18) did not oxidize. The addition of UOP No. 5 Inhibitor with or without caustic did prompt an appreciable reaction. However, in no Run was a complete, reasonably rapid rate of mercaptan consumption achieved. The amount of oxygen absorption was about 1 mole/mole RSH consumed, with disulfide formation less than 4%. The t-butyl mercapto free radical can add to the olefin with sufficient ease to form a hydroperoxide derivative (see Step 1 in the chemical equations), but the inertness of t-butyl mercaptan toward oxidatiton by the peroxide (Step 2) prevents completion of the cycle essential for inhibitor sweetening. The increase in olefin reactivity is of value in accelerating Step 1, but is of little value in promoting Step 2.

Is Caustic Required?

Successful inhibitor sweetening on a commercial scale does require the presence of a basic material in at least small amounts. The catalytic effect of caustic has been demonstrated by investigating the oxidation of mercaptans in olefins under carefully controlled conditions. A further investigation of the effect of variations in nature of the caustic is of interest for several reasons: certain modifications in the basic material may favor a more efficient consumption of mercaptan, and from such an investigation one may define more clearly the role of the basic material in relation to the chemistry involved. From a practical point of view, it is considered desirable to bring about rapid mercaptan consumption with minimum oxygen absorption and peroxide formation.

The oxidation of n-butyl mercaptan in cyclohexene in the presence of UOP No. 5 Inhibitor and various basic materials was effected in the first four experiments as reported in Table 3. The use of an aqueous solution of ammonia (Run 21) an piperidine (Run 23) gave a rapid absorption of oxygen but with decreased disulfide formation. Benzyltrimethyl ammonium hydroxide gave an incomplete but satisfactory reaction. It is apparent that substitution for aqueous sodium hydroxide is possible but with no improvement in results.

A complete and rapid reaction, with no peroxide formation and with low oxygen absorption was obtained (Run 24) using a methanol caustic solution (1 part NaOH, 1 part water, 2 parts methanol). With this caustic, a clear cut reaction occurred as is evident by the values obtained, which approach the theoretical for inhibitor sweetening. In view of this effect, oxidations in methyl-1,3-pentadiene (Run 25) and styrene (Run 26) were conducted with methanol caustic. In each situation, satisfactory mercaptan consumption was realized in a straight-forward manner. The beneficial results with methyl-1,3-pentadiene were particularly noticeable because the methanol caustic eliminated peroxide formation.

*See footnote, p. 91

Table 4—Oxidation of n-Butyl Mercaptan in Benzene by a Peroxidized Thiophenol-Cyclohexene Mixture

Duration of storage, hrs	0		20	
	RSH[a]	Peroxide[b]	RSH[a]	Peroxide[b]
Mixture A:				
80% Benzene				
20% Peroxidized thiophenol-cyclohexene	0	8.4	0	8.25
Mixture B,				
Mixture A plus n-Butyl Mercaptan	9.3	—	8.9	1.95
Mixture B, 50 ml. plus				
0.1 ml 20% NaOH	—	—	1.9	0
0.1 ml UOP No. 5	—	—	8.5	Trace
0.1 ml 20% NaOH and UOP N. 5	—	—	2.3	0

(*a*) Equivalents per ml x10^5
(*b*) Equivalents per ml x10^5, determined iodometrically.

Table 5—Large Scale Inhibitor Sweetening at Room Temperature

(Time of Reaction 4-7 hrs)

Run	1	2	3
Charge, grams:			
Olefin	Cyclohexene	Cyclohexene	Methylpentadiene
Weight	396	145	317.5
n-C_4H_9SH	43.2	18.5	35.5
UOP No. 5 Inhibitor	2.0	.9	1.5
20% NaOH	3.0	1.0	1.0
Products: Yield, % Theoretical:			
N-butyl disulfide	52[1]	—	50[6]
2-hydroxycyclohexl n-butyl sulfide	14[1,2]	11[1]	—
hydroxyhexenyl n-butyl sulfide	—	—	28[5]
n_D^{20}	1.4992	1.4998	1.4908
Boiling pt., °C	99° (1.8mm.)	137° (11.9mm.)	112° (7.2mm.)-100° (1.0mm.) or 255°-290° mainly about 277°
Cyclohexyl n-butyl sulfide	15[1,4]	4.5	

(1) Yields based on mercaptan consumed (33.3 grams, 0.369 mole).
(2) Yield of trans-2-hydroxycyclohexyl n-butyl sulfide.
Properties of synthesized trans compound
B. P., 86° (1.4mm.); n_D^{20}, 1.4993.
(3) Calcd. for $C_{10}H_{20}OS$: C, 63.78; H, 10.70; S, 17.0. Found: C, 63.82; H, 10.72; S, 16.6.
(4) Properties of synthesized cyclohexyl n-butyl sulfide:
B. P., 106° (12mm.); n_D^{20}, 1.4888. Analysis. Calcd. for $C_{10}H_{20}S$:
C, 69.70; H, 11.70; S, 18.60. Found: C, 69.80; H, 11.74; S, 18.70.
(5) Analysis. Calcd. for $C_{10}H_{20}OS$: C, 63.78; H, 10.70; S, 17.0. Found: C, 63.04; H, 10.68; S, 16.86.
(6) Analysis. Calcd. for $C_8H_{18}S_2$: C, 53.87; H, 10.18; S, 35.95. Found: C, 54.39; H, 10.52; S, 35.44. n_D^{20}, 1.4920.

decreased the oxygen absorption and increased the disulfide formation.

Where Can Sweetening Reactions Occur?

It is possible to realize inhibitor sweetening in a single phase system, as evident by the results obtained with piperidine, a hydrocarbon soluble base. However, a two phase system generally is present because the basic material normally contains water as a component. The superior results obtained with the methanol caustic indicate that it is desirable to use solutions that readily extract the mercaptan, also that the mercaptan conversion takes place in the caustic phase.

To determine the course of reaction with the mercaptan predominately in the methanol caustic phase, the oxidation was conducted with sodium hydroxide present in amount about equivalent to the mercaptan (Run 27). The mercaptan was rapidly oxidized, apparently either directly by oxygen to the disulfide, or by the normal inhibitor sweetening sequence. The direct oxidation to disulfide under these conditions is a factor, made evident by the results from Run 28 in which UOP No. 5 Inhibitor was not present. One can conclude that inhibitor sweetening can ensue with the mercaptan in the caustic phase, but in competition to the direct oxidation.

The superior results obtained with methanol caustic prompted experiments on oxidations of secondary and tertiary butyl mercaptan; the latter is particularly difficult to bring into reaction. With cyclohexene as the olefin, sec-butyl mercaptan underwent inhibitor sweetening with greater ease (Run 29) than with aqueous caustic (Part 1, Run 9). But the use of methanol caustic with cyclohexene (Run 30) was insufficient to promote much reaction of t-butyl mercaptan.

The use of methyl-1,3-pentadiene as the olefin with methanol caustic (Run 31) did effect complete consumption of t-butyl mercaptan but the results (high oxygen consumption, high peroxide formation and low disulfide formation) indicate that normal inhibitor sweetening is not the major course of reaction. The t-butyl mercaptan can form mercapto free radicals that add to the olefin, as indicated by results from Run 31, but the difficulty encountered is the inability of the peroxide from Step 1 to oxidize the mercaptan to disulfide as required in Step 2.

The presence of caustic is essential for Step 2. The favorable results obtained with methanol caustic can be considered mainly caused by the speeding up of Step 2 in the sweetening sequence so that proper disposition can be made of the products from Step 1.

The following experiments, as presented in Table 4, shows how essential caustic is in Step 2. Mixture A was obtained by diluting with benzene a peroxide-containing solution obtained by oxidizing thiophenol in cyclohexene. This solution had a stable perixide content over a period of 20 hours. Peroxide instablity was brought about by the addition of n-butyl mercaptan (Mixture B), with the mercaptan itself not being consumed. It is only the addition of caustic to Mixture B that gave mercaptan consumption; UOP No. 5 Inhibitor effected no appreciable mercaptan disappearance. These observations are strong evidence of the role of caustic in inhibitor sweetening.

Some General Conclusions

The data presented here establish that the nature of the basic material is important in determining the effectiveness of inhibitor sweetening. It is noteworthy that alterations in the caustic, a minor component of the reaction mixture, do have a noticeable affect on the rate and course of reaction.

The mechanism for inhibitor sweetening has been based to a considerable extent on kinetic and analytical data. The isolation of specific oxidation products, as indicated, would be further evidence supporting the correctness of the proposed mechanism. Reaction products from inhibitor

sweetening have been segregated and identified, as summarized in Table 5 in for n-butyl mercaptan with two olefins.

The identification of the hydroxy sulfide is of special interest because its formation specifically identifies part of the sweetening cycle. With cyclohexene, yields of 11% and 14% of 2-hydroxy-cyclohexyl n-butyl sulfide were obtained—⅓ to ½ of the theoretical yield of 33%. With methylpentadiene a 28% yield of a hydroxyhexenyl n-butyl sulfide was realized. The latter result can be considered as excellent confimatory evidence.

The configuration of the 2-hydroxycyclohexyl n-butyl sulfide is essentially that of the trans form (over 80%). This fact is based on infrared comparison with a synthetic sample prepared by the trans addition of n-butyl mercaptan to cyclohexene oxide. This observation indicates a high geometrical selectivity in free radical additions to double bonds.

With cyclohexene, the formation of cyclohexyl n-butyl sulfide is appreciable (yield 15% in Run 1). The formation of this compound can be considered caused by chain-transfer reactions that do not alter the stoichiometry or kinetic treatment of the process.

This paper has considered the chemical aspects of oxidation by air of mercaptans in a cracked gasoline as catalyzed by UOP No. 5 Inhibitor. The process is remarkable in that this effective antioxidant of the p-phenylenediamine type induces a selected oxidation involving the mercaptans. The data presented, which was obtained using pure chemicals, describe the properties of the antioxidant that initiate mercaptan consumption, the reactions by which oxygen is brought into the oxidation cycle, and the effects of variations in the nature of mercaptan, caustic and olefin. The mercaptans can be involved in a number of reactions, but under proper conditions, there is a definite pattern consisting of a two step sequence by which mercaptans are rapidly and cleanly consumed to give true inhibitor sweetening.

Experimental Information

The experimental procedure and equipment were described in the earlier paper.*

The sources of olefins and reagents (purified by distillation) are as follows:

1-Octene, Humphry-Wilkinson.

Styrene, Dow Chemical Co.

Methyl-1, 3-pentadiene, Shell Chemical Corp., containing 85% 4-methyl-1, 3-pentadiene and 15% 2-methyl-1, 3-pentadiene.

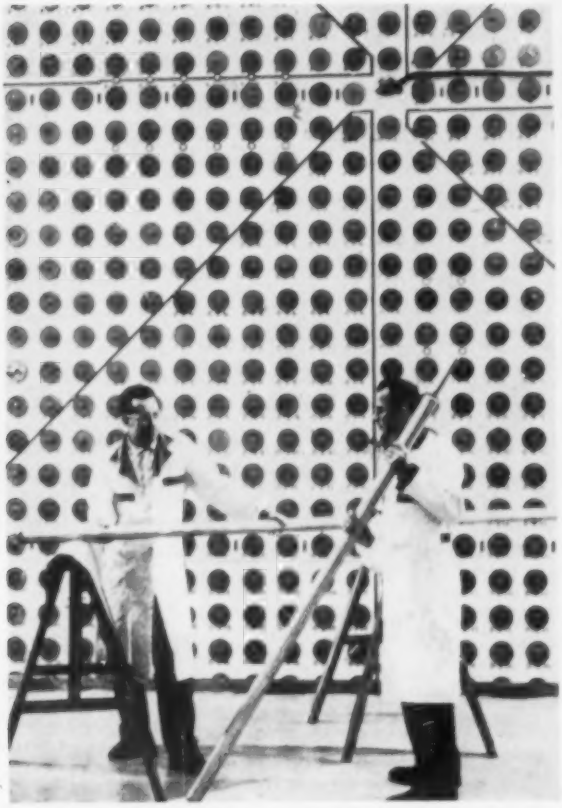
n-Butyl mercaptan, Eastman-Kodak Co.

t-Butyl mercaptan, Phillips Petroleum Co.

Refinery Caustic, obtained from plant operation—or 20%-wt. solution of NaOH.

*See footnote p. 91

NEWS in VIEWS



MINATURE REFINERY IN ATOMIC PILE. Atlantic Refining Co. has installed a "loop" reactor in pile at Brookhaven Laboratory, and studies effects on petroleum samples flowing through this loop.

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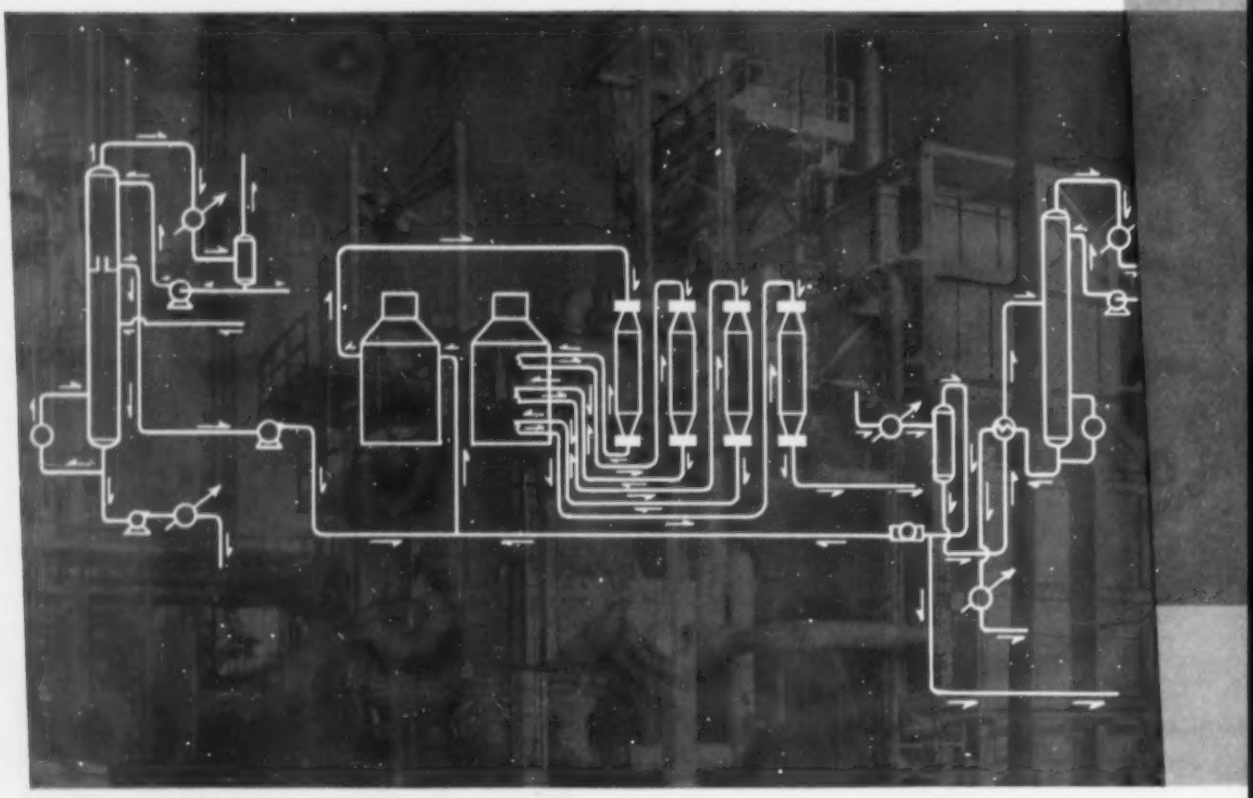

Simplified flow diagram of Platforming Process

Platforming, developed by UOP and introduced in 1949, pioneered the use of platinum in a catalyst for refining gasoline and is today one of the world's most widely used processes. Early in its development, our research team realized that Platforming offered a practical means of helping meet the chemical industry's growing demand for aromatics. Experimentation indicated that, by employing certain modifications in operating conditions, high yields of aromatics were possible through Platforming. This was only a partial solution because the problem of separation of aromatics in the degree of purity required by the chemical industry still remained.

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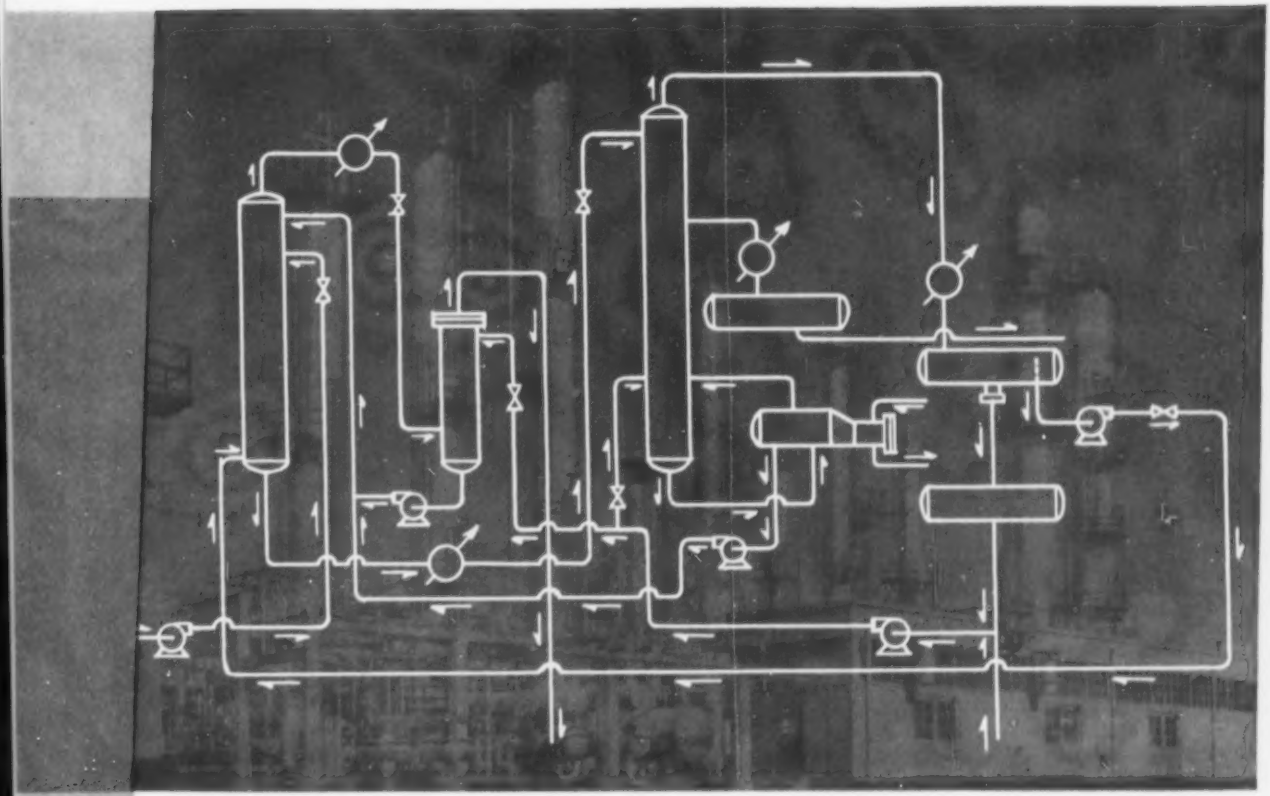

Simplified flow diagram of Udex Process

Udex, developed by Universal in cooperation with Dow Chemical Company, provided the answer. It successfully created and applied the separation equipment necessary to concentrate the aromatic hydrocarbons produced by Platforming into the form required by the chemical industry. This combination of UOP's Platforming and Udex processes, an outcome of a basic research program originally directed toward motor fuels, is an outstanding example of the broad scope of UOP research.

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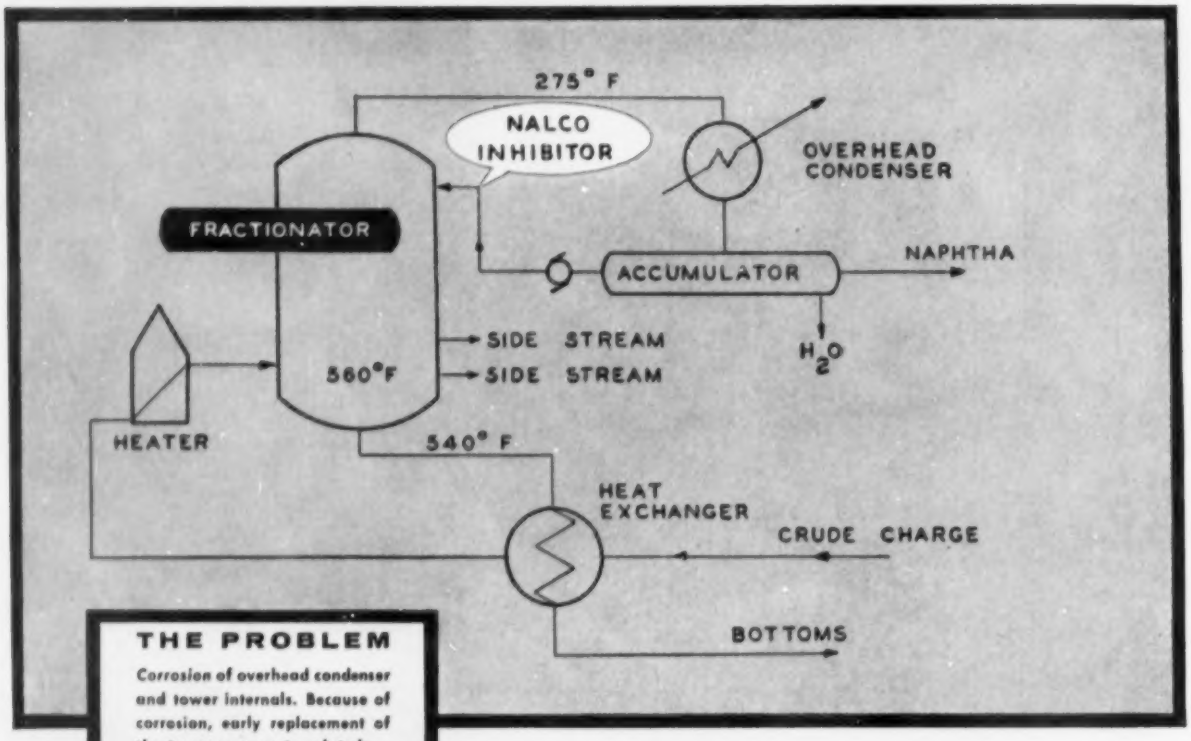

THE PROBLEM

Corrosion of overhead condenser and tower internals. Because of corrosion, early replacement of the tower was contemplated.

THE TREATMENT

Nalco Corrosion and Fouling Inhibitor applied into overhead reflux.

THE RESULT

In this case only one point of application protected both fractionator and overhead equipment. Iron in accumulator water brought below 0.5 ppm as compared to previous 100-150 ppm. Corrosion and plugging stopped, tower saved, and downtime for cleaning reduced by 74%.

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A scheme for using an hydraulic motor drive for a cooling fan, how to keep a tool-room dust-free, portable lights for night maintenance chores, new tricks for repairing pumps. See this month's Plant Practices, on . . . **p. 107**

How Important is the Third Grade?

The industry is seething with activity and opinion because of the early arrival of 100 octane at the filling station, either as a new premium grade, or as a new additional third grade. What should we be thinking and doing about it. Editorials. **p. 176**

A Case of Magnetism

The Old Man told Soup Dixon he wasn't "about to climb any scaffold" just to show the Bull Pen boys how to lick a nasty welding job. He had an idea or two of his own. To find out what he did, turn to this months' episode. **p. 111**

Reforming in Reverse?

That's one way to describe a new process discussed in the Patents this month. See also the newly revised listings of Patent Briefs that has been designed to make it easier for you to find patents on specific subjects. **p. 127**

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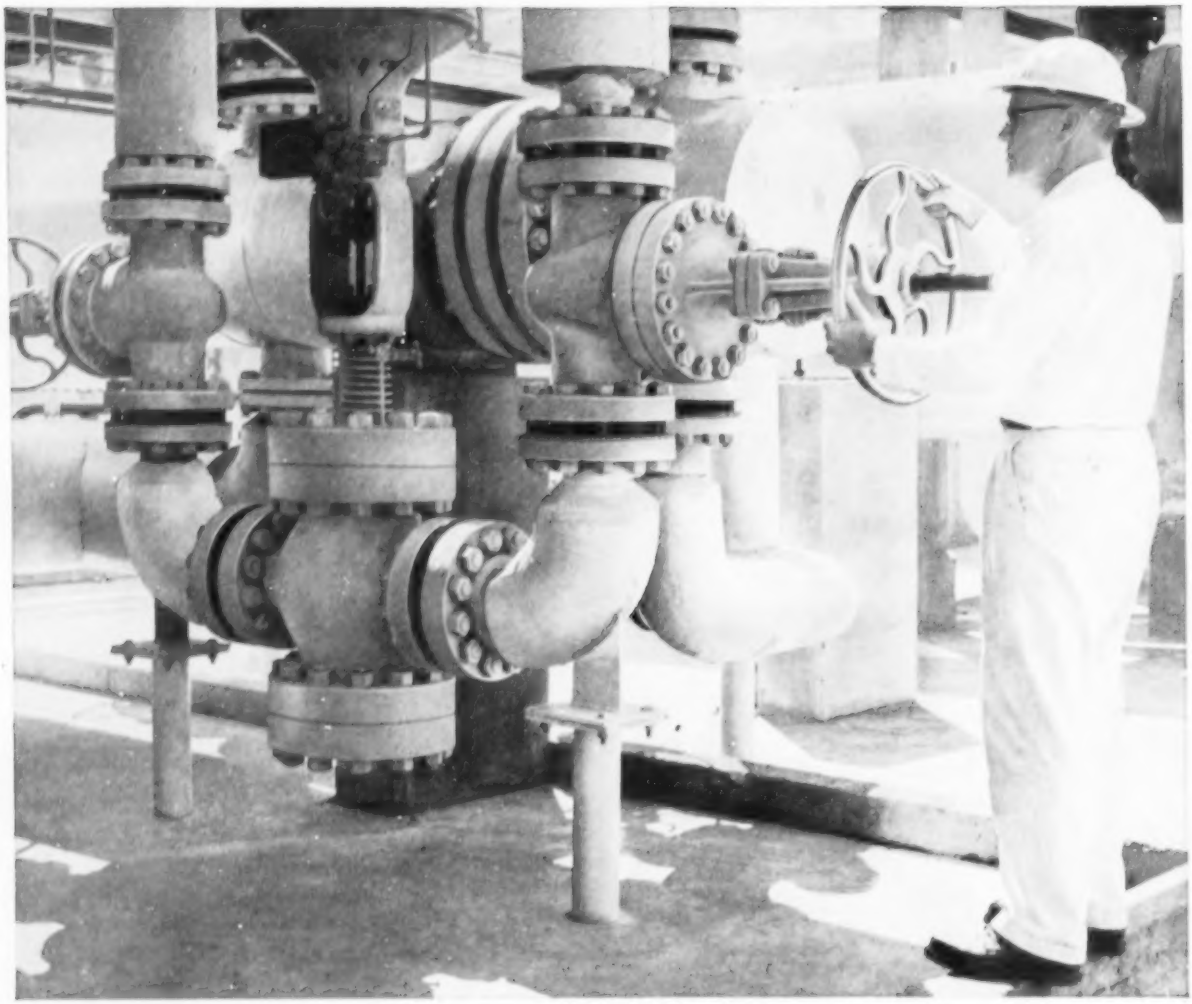

This Crane valve tight and trouble-free after 3 years on severe reboiler service

Here's the kind of valve performance every refinery would like to be getting.

When Delhi-Taylor Oil Corp. built the U.O.P. platformer unit in their Texas refinery in 1953, they installed this Crane 8-inch No. 83X 900-pound steel valve on the lines to the reboiler. The valve—a wedge gate type—handles platformates mixed with hydrogen gas at 550 psi. and 900° F.

What's the story on this Crane valve after 3 years on this extra-severe service? No maintenance of any kind—and it's closing just as tight and sure as it did the day it went on the line.

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Process—Fixed-bed catalytic isomerization of low-boiling normal paraffins (normal pentane, hexane and heptane) to isoparaffins.

Process Flow—The flow diagram illustrates operation on a mixture of pentane, hexane, or heptane paraffins. The normal paraffin is first separated from its isomers in a conventional fractionating tower. The bottoms product, rich in normal paraffin, is charged to the Pentafiner.

The normal paraffins are mixed with hydrogen recycle, preheated in exchange, and heated to reaction temperature in a furnace. The mixture is then passed downward through a single fixed bed of catalyst in which the temperature rises slightly. The reactor effluent is then cooled by exchange with the feed and condensed in a water cooler. The liquid separates from the recycle gas in a flash drum and then passes under level control to a simple degasser tower for removal of butanes and lighter.

The gas from the flash drum is recycled to the reaction section. After degassing, the equilibrium mixture is recycled to the splitter for separation of isoparaffins. A small amount of hydrogen is continuously added to the Pentafiner to hydrogenate the products of cracking, and hold pressure on the unit.

Catalyst—Pentafining catalyst is a combination of platinum, silica, and alumina specifically designed to promote isomerization with insignificant cracking and disproportion to fuel gas. Catalyst cost will be about four cents per barrel of feed to the Pentafiner. It is manufactured by Davison Chemical Company, a division of W. R. Grace & Company, and is supplied as cylindrical pellets.

Sulfur in the feed is handled by caustic washing to remove low-boiling mercaptans and hydrogen sulfide, or by a conventional amine scrubber on the recycle gas.

Regeneration—The catalyst may be regenerated in place to extend its life, or to correct for operating upsets. No "swing" reactor is required. A dilute mixture of air and steam at 500-1000°F and low pressure is used to restore activity to that of fresh catalyst.

Operating Conditions—Operating conditions depend upon the boiling range of the charge stock. Pressure is in the range of 300-700 psig, catalyst temperature 700-900°F, space velocity 1-6 pounds of feed per hour per pound of catalyst, and recycle ratio of 2-6 mols hydrogen per mol of feed.

Process Variables—The extent of isomerization is

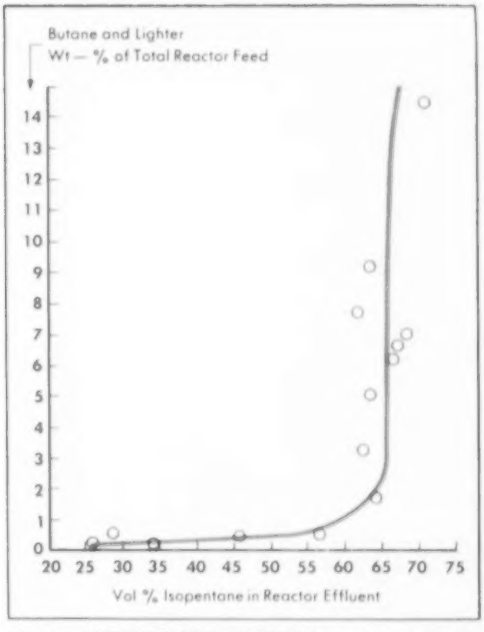


Fig. 1—**BUTANES AND LIGHTER** versus isopentane in reactor effluent, during isomerization of normal pentane

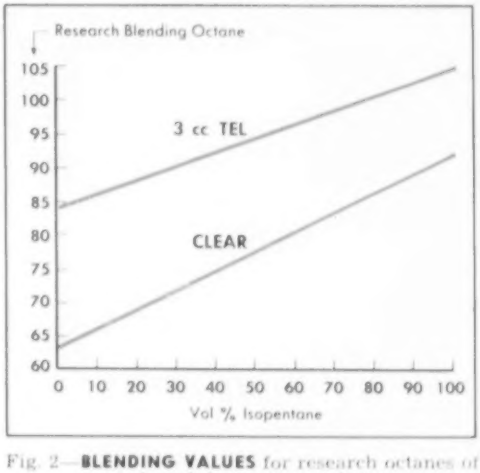
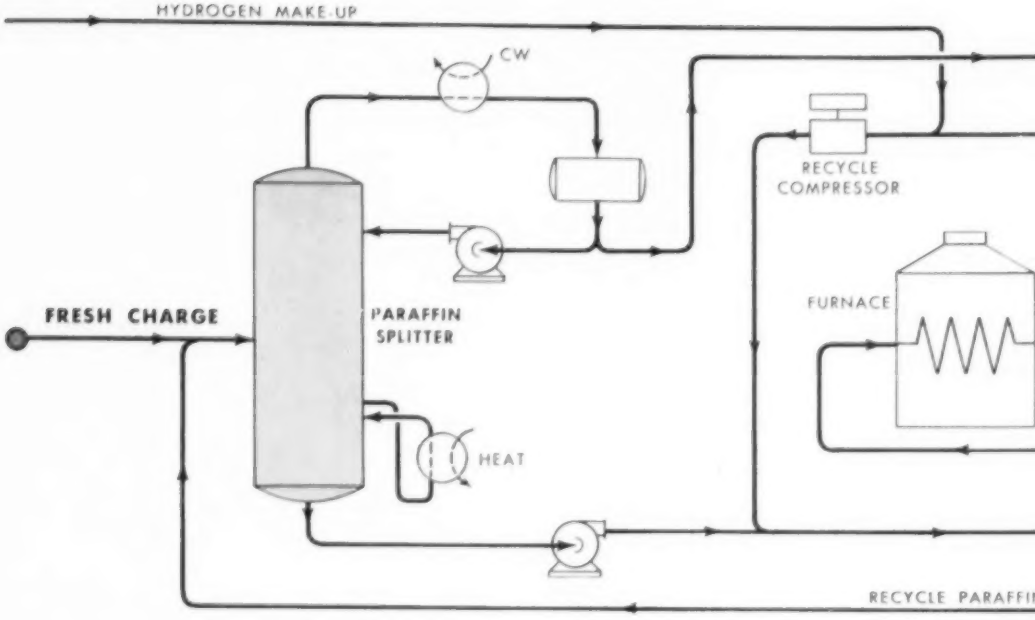


Fig. 2—**BLENDING VALUES** for research octanes of normal and isopentane mixtures

controlled simply by changing the reactor inlet temperature. As the catalyst gradually accumulates carbon, the temperature is raised to maintain isomerization activity.

Equipment—The equipment is similar to that used for reforming low-sulfur charge stocks. A nominal amount of alloy is required at temperatures above 500°F to prevent hydrogen attack.

Feedstock—Feedstocks should be rich in normal pentane, hexane, or heptane. All three may be isomerized together, but highest once-through conversions are obtained with a separate reaction section for each. For purposes of illustration, a feedstock consisting of 50% normal pentane and 50% isopentane was assumed, and a high-effi-



ciency pentane splitter was used to concentrate the normal pentane.

Product Yields—Fig. 1 shows the butane and lighter yields from once-through isomerization of pentanes as a function of the concentration of isopentane is the reactor product. A complete breakdown of the once-through products is shown just below. When a 50-50 mixture of normal pentane and isopentane is charged to the combination of a pentane splitter plus a Pentafiner, an over-all yield of 97-98 volume per cent of 95% isopentane can be achieved. Octanes of mixtures of normal—and iso-pentane or shown in Fig. 2.

Pentafining Yields—Once-Through Basis

(Feedstock: 50% n-pentane, 50% isopentane)

Components	Yield, wt% of total feed
Methane	0.12
Ethane	0.07
Propane	0.09
Isobutane	0.10
Normal Butane	0.65
Isopentane	58.90
Normal Pentane	39.62
Hexanes	0.45

Utilities—Utilities for the combination of a Pentafiner and a pentane splitter, converting 2000 b/sd mixed pentanes to 95% isopentane, are shown in the box below.

Economics—The cost of converting 2000 b/sd mixed pentanes to 95% isopentane is shown on the facing page.

Licensor—The Atlantic Refining Co., Research & Development Dept., 2700 Passyunk Ave., Philadelphia, Penna.

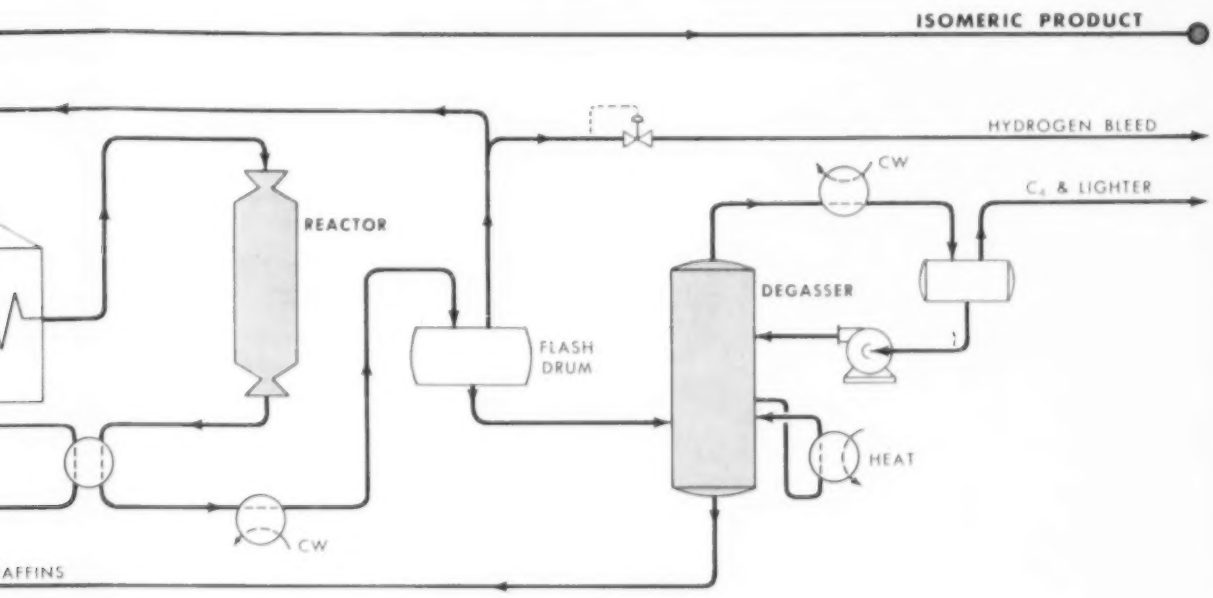
References—Articles published about Pentafining process, and related subjects, include:

(1) Ciapetta, F. G., and J. B. Hunter, "Isomerization of Saturated Hydrocarbons in Presence of Hydrogenation-Cracking Catalysts," *Industrial & Engineering Chemistry*, 45, 147 (January, 1953).
(2) Fowle, M. J., R. D. Bent, and B. E. Milner, "Chemical Conversion by Isomerization and Dehydrogenation with Catforming," Proceedings of the Fourth World Petroleum Congress, Rome, Italy (June, 1955).
(3) *Oil and Gas Journal* 54, No. 46, 183 (March 19, 1956).
(4) Worrell, G. R., "Now 100 Octane from Natural Gasoline," *Petroleum Refiner* 35, No. 4, 138 (April, 1956).
(5) Worrell, G. R., "Progress Report on Selective Isomerization," *World Petroleum* 27, No. 8, 74 (July, 1956).

Utilities Required for Pentafining

(Basis: 2000 b/sd fresh charge of 50% n-pentane, 50% isopentane)

	Pentafiner	Pentane Splitter	Total
Charge rate, b/sd	1783	3758	2000
Fuel needed, MM Btu/hr	7	53	60
Electricity for pumps & cooling tower fans, kw	65	213	278
Steam, lb/hr	1600	0	1600
Cooling tower water make-up, gpm	30	128	158



Isomerization of Normal Paraffins

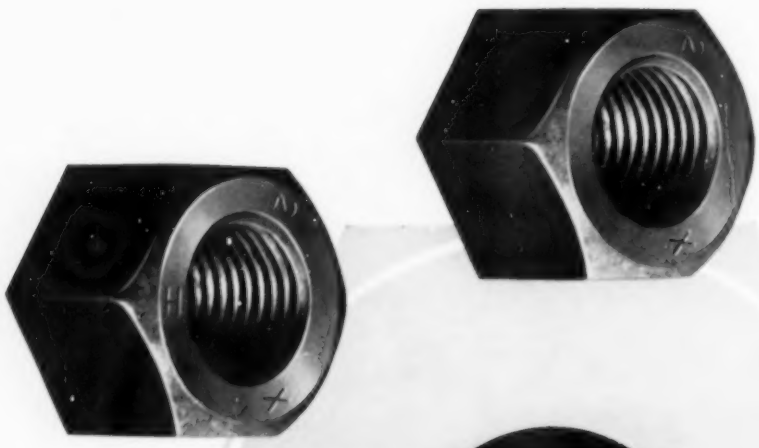
With Atlantic Refining's Pentafining Process

UNFOLD FOR START OF PROCESS DESCRIPTION

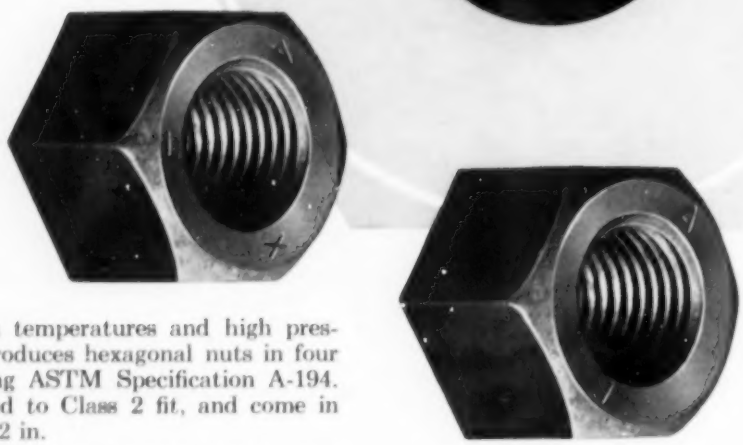
Pentafining Economics—2000 b/sd Fresh Charge to Unit

(Basis: charge of 50% n-pentane, 50% isopentane; 96% time efficiency)

	Pentane Splitter	Pentafiner	Total
Charge rate, b/sd	3,758	1,783	2,000
Inside battery investment, $	600,000	235,000	835,000
Fixed charges, $/cd	110	88	198
1 opeerator @ $2.50/hr	20	40	60
Supervision & clerical @ 40% of labor	8	16	24
Maintenance @ 2½% of investment/yr	41	16	57
Insurance & taxes @ 2½% of invest./yr	41	16	57
Variable charges, $/cd	240	125	365
Fuel @ $0.15/MM Btu	183	24	207
Electricity @ $0.008/kw	39	12	51
Steam @ $0.30/M lb	0	11	11
Cooling water make-up @ $0.10/M gal	18	4	22
Catalyst	0	74	74
Total direct operating cost, $/cd	350	213	563
Total direct operating cost, ¢/bbl	9.7	12.4	29.3



Four Types of Nuts... And They All Meet A-194



For service at high temperatures and high pressures, Bethlehem produces hexagonal nuts in four grades, each meeting ASTM Specification A-194. The nuts are tapped to Class 2 fit, and come in sizes from $\frac{3}{8}$ in. to 2 in.

GRADE 1 Low-carbon steel. Suitable for non-critical applications; also for use at moderately elevated temperatures. Carbon 0.15 min, Phosphorous 0.05 max, Sulphur 0.05 max. Brinell hardness 120 min.

GRADE 2 Medium-carbon steel, specially intended for use at moderate temperatures and pressures. Carbon 0.40 min, Phosphorous 0.05 max, Sulphur 0.05 max. Brinell hardness is 160 min.

GRADE 2H Excellent for high-temperature, high-pressure service because it is quenched and tempered. Carbon 0.40 min, Phosphorous 0.05 max, Sulphur 0.05 max. Brinell hardness 248 to 352.

GRADE 4 Molybdenum steel, heat-treated. For severe temperature and pressure conditions. Bethlehem Grade 4 nuts are also ideal for sub-zero service, their 4L marking indicating they meet the impact requirements of Spec. A320 for low-temperature bolting. Nut has minimum Charpy impact value of 15 ft-lb down to —150 F. Carbon 0.40 to 0.50, Manganese 0.50 to 0.95, Phosphorous 0.04 max, Sulphur 0.05 max, Silicon 0.15 min, Molybdenum 0.20 min. Brinell hardness 248 to 352.

If you would like to have additional information, just drop a line to the nearest Bethlehem office.

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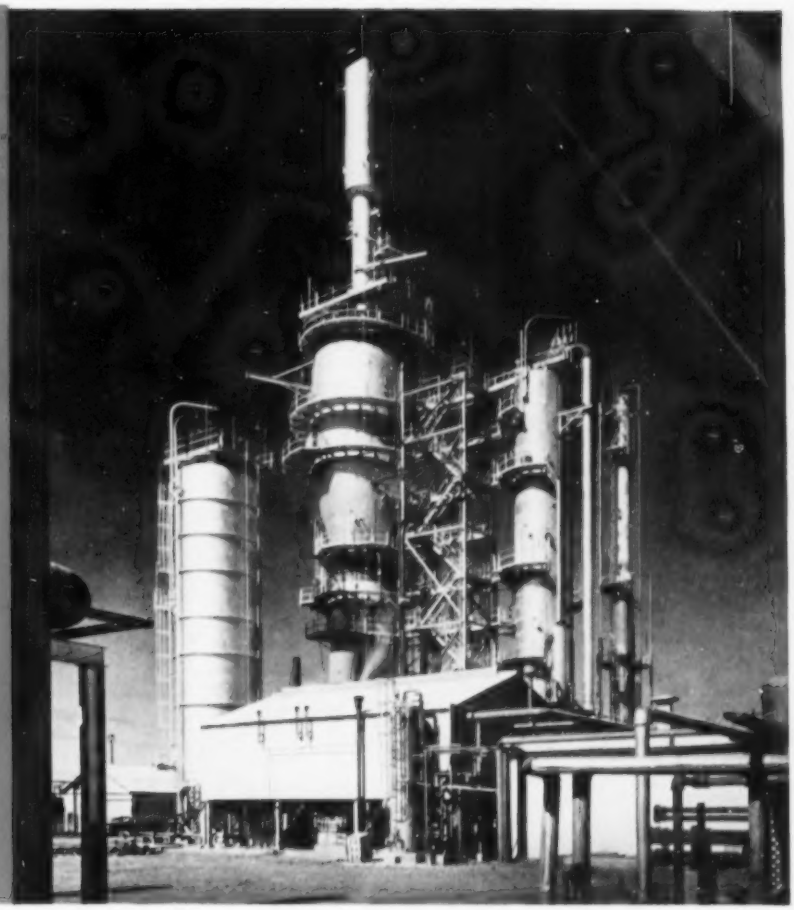

Champlin's Orthoflow* Proves Itself

FLUID CATALYTIC CRACKER

When Champlin Refining Company became part of The Chicago Corporation, up to $10 million was invested in a modernization program to expand capacity and raise octane level of its Enid, Oklahoma refinery. A major factor in minimizing initial cost of these facilities and getting them on stream quickly and efficiently, was an Orthoflow Fluid Catalytic Cracker. Designed and built by The M. W. Kellogg Company for a fresh feed capacity of 9,000 BPD, and total throughput of 13,500 BPD, this Orthoflow also promises minimum maintenance.

The Orthoflow was erected by M. W. Kellogg well ahead of schedule, and went on stream without trouble immediately on completion. Within a month of initial operation, the unit fulfilled the Kellogg guarantees and was accepted. It operated continuously for 3 months, when repairs on the lube oil pump required a shutdown. This also permitted complete inspection of the interior of the Orthoflow, and reassured Champlin that the unit's lining and general condition were excellent. After 5 days, the unit was back in service, and ran without interruption for 5 months. Total time in service at this writing: 8 months. Total time out: only 5 days! The Orthoflow is now operating at 79% conversion rate, and about 10% above original design capacity.

The Champlin unit is one of seventeen Orthoflow Fluid Cat Crackers engineered or erected by The M. W. Kellogg Company for leading refiners throughout the world, with throughput capacities ranging from 3,500 BPD to 102,000 BPD. The trend toward this vertical-design cat cracker is graphically explained in a full-color, 15-minute animated movie. Refiners interested in seeing this film in their offices can make arrangements by contacting M. W. Kellogg.

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(To obtain more data on advertised products see page 142)

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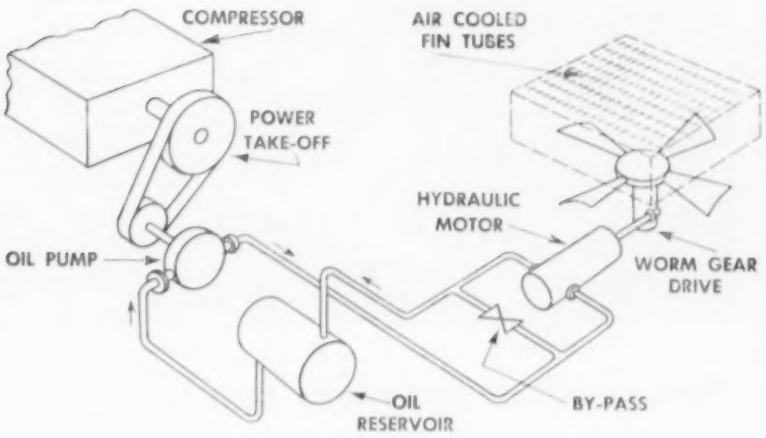


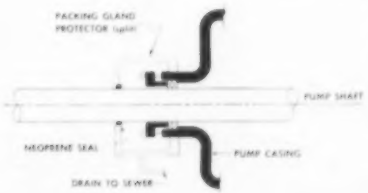
Hydraulic Motor Drives Adjustable-Speed Fan

THE CHICAGO CORP. recently added additional gas compression facilities at its Carthage gasoline plant at Carthage, Texas. Air-cooled fin tubes were selected, rather than a new cooling tower for controlling the temperature of the engine jacket water, mainly because of economics.

The next problem was how to power the fans for these coolers. The electrical system was loaded to capacity, so the choice seemed to be between adding more electric generating capacity or buying power. But additional capacity and outside power sources were both expensive.

Chicago Corp.'s ingenious solution was a hydraulic power system operated from the compressor drives. A V-belt take-off from the new compressors drives an oil pump that pressurizes the system to 425 psi. The hydraulic fluid —ordinary SAE 30 lubricating oil—is pumped through a 3-in. piping system to a hydraulic motor that drives the fan. The fan speed is adjusted manually by by-passing part of the oil around the hydraulic motor.

During operation in moderate temperatures, the oil heats to about 125 F and reaches just the right viscosity for efficient operation. In hot weather, the oil is changed to an SAE 40 to maintain proper viscosity.

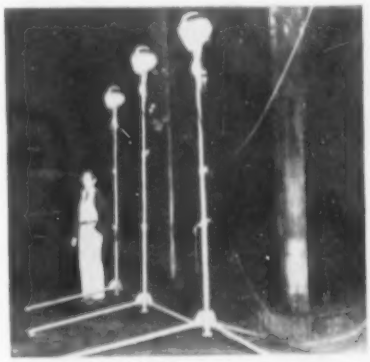


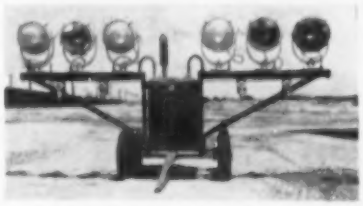
"Throw-Away" Shield Cuts Pump Corrosion

ACID handling pumps often destroy themselves when their packing glands leak corrosive liquids. Steel bases or pedestals are quietly and quickly eaten away, causing not only expensive replacements but annoying outages as well. And serious leaks create personnel hazards and potential damage to nearby equipment.

A simple but effective protector is shown at left. Devised by Lloyd Gibson a mechanical department machinist, this packing gland protector is used in the Baytown refinery of Humble Oil and Refining Co. Split down its axis and bolted around the pump shaft, this simple housing confines any spraying acid. Escaping acid is then drained to the sewer; and corrosion to the pump and a hazard to operating personnel are eliminated.

Although the protector itself does corrode rapidly, its replacement is simpler and cheaper than replacement of the pump base.





Portable Lighting Improves Night Maintenance Jobs

STANDARD OIL CO. (Ohio) has developed two portable units for emergency lighting at its Covington, Kentucky, refinery. The units, which were designed by T. L. Clift, an engineer in the electrical and instrument department, are used not only for emergency night work but general outdoor maintenance work as well. The explosion-proof unit is also used for interior tank cleaning.

The heart of the lighting setup is a 7.5 KW portable generator, equipped with six floodlights. Mounted on adjustable outriggers, the two banks of floodlights deliver 35 foot candles of light over the surface of an object 50 ft away. Three of the floodlights are wide beam and three are narrow beam. Together they can illuminate the entire side of a refinery tank, providing both general light and pinpoint illumination.

For hazardous areas, another battery of four explosion-proof floodlights can be attached to explosion-proof plug receptacles at the same generator. These floodlights with cast aluminum fixtures can be arranged inside a tank for washing or inspection purposes. Retractable aluminum tripods permit raising the floodlights from 5½ ft to 10 ft above the ground or bottom of a tank.

Continued on next page

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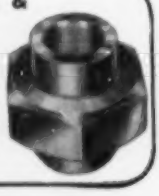

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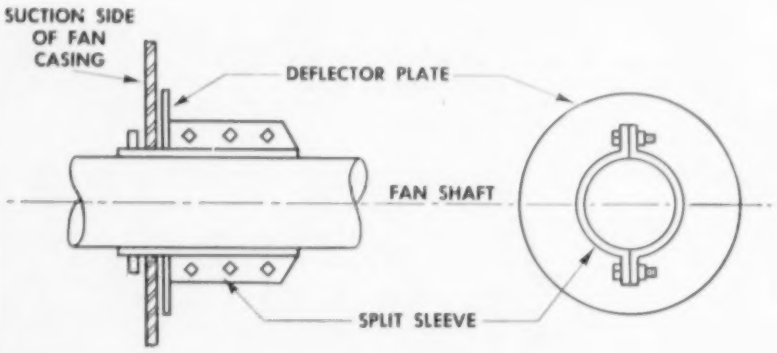
War on Dust Invades Toolroom

BIG SPRING, Texas, location of Cosden Petroleum Corp.'s refinery, is noted for its dust and sand storms. This makes good plant and shop housekeeping more difficult than usual. High summer temperatures also require shop ventilation.

These special conditions have dictated the layout of the maintenance shop and its equipment. At first glance, the above picture of a portion of the shop stockroom may not look different from many other stockrooms. However, note the large tool racks for air hammers, jacks, turbine cutters and other equipment. Made from conventional structural shapes, these have no large, flat areas to collect dust. Instead, the inclined metal surfaces retain little dust and can be readily cleaned both topside and underneath.

The bins for small parts, which are notorious dust and dirt catchers, are also unusual. These are made from steel angles and covered on four sides with tackwelded expanded metal sections. The bin partitions are of the same material.

This construction—done entirely by plant personnel—not only lets dust fall through but also improves lighting. Even the bottom bin in the middle row is adequately lighted for inventorying. The expanded screen construction also assures good circulation of air for ventilation purposes.



Protective Sleeve Cuts Corrosion

BOILER FLUE gases have a way of corroding the shafts of induced draft fans at the casing seal. The culprits are corrosive fluids, such as sulfuric acid, which condense from the hot flue gases when they contact cold infiltering air. These corrosive condensates settle on the shaft just inside the fan casing. In some cases, shaft diameters have been reduced as much as one inch by this corrosion.

Metallizing is usually only a temporary solution, and then may be ineffective. The shaft must eventually be replaced. But Humble Oil and Refining Co. has developed an effective solution at its Baytown refinery. It consists of a simple, shop-made pro-

tective sleeve and deflector plate that stops this corrosion.

Devised by Mr. Lloyd Gibson, a machinist in the mechanical department, the protector is, in effect, a simple, mechanical seal. It consists of a split sleeve plus a deflector collar that bolts to the fan shaft at the casing seal. If anything corrodes, it's the protecting sleeve instead of the critical shaft. Humble has found that replacement of the protector is simple, as well as inexpensive compared to the cost of shaft repairs.

Simple Mop Rack Improves Housekeeping

A SIMPLE, plant-made mop and broom rack at the Sunray natural gasoline plant of the Shamrock Oil and Gas Corp., near Sunray, Texas, affords convenient storage for both wet and dry cleaning equipment. It also eliminates floor puddle caused by wet hanging mops.

Made from a 55-gal drum, the rack has a wooden support attached to the sides of the drum to hold the floor cleaning equipment. Wet mops hang in the center of the support so that dripping water will fall into the drum, not on the floor. Slots in the ends of the horizontal wooden piece, mounted above the drum, permit hanging all types of dry mops, brooms and dust pans.

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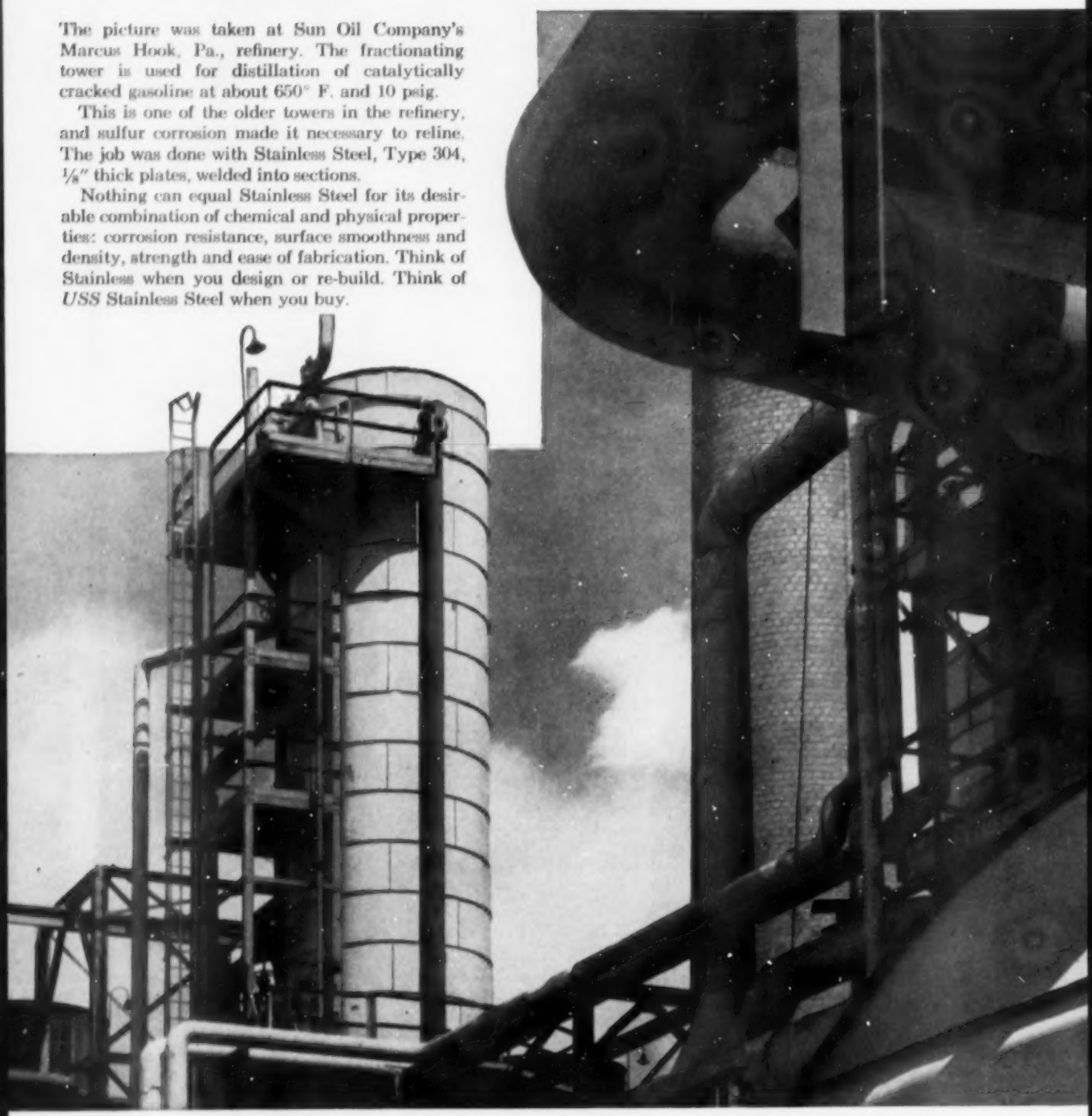
Stainless Steel reduces sulfur corrosion in Sunoco fractionating tower

The picture was taken at Sun Oil Company's Marcus Hook, Pa., refinery. The fractionating tower is used for distillation of catalytically cracked gasoline at about 650° F. and 10 psig.

This is one of the older towers in the refinery, and sulfur corrosion made it necessary to reline. The job was done with Stainless Steel, Type 304, ⅛" thick plates, welded into sections.

Nothing can equal Stainless Steel for its desirable combination of chemical and physical properties: corrosion resistance, surface smoothness and density, strength and ease of fabrication. Think of Stainless when you design or re-build. Think of *USS* Stainless Steel when you buy.



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UNITED STATES STEEL

A Case of Magnetism

THE BOYS in the bull pen were in rare form this particular day—a lot of hee-hawing and monkey-shines as usual, but a surprising amount of business being conducted too. We had a tough job going in the boiler house in preparation for a big expansion to start the following month. The hottest thing was replacing the old steam header with a larger one to take care of the additional steam capacity expected from the new boilers.

"Soup" Dixon, the welder foreman, came shuffling in, looking sadder than usual. Incidentally, "Soup" got his name because, as the Old Man once said, he was the only man alive who could get soup stains on a bow tie. Anyway, we could see "Soup" was troubled.

"Dan," he said to the area engineer, "I'm up against one now. We can't weld on that steam header."

"Why not?" asked Dan.

"It's magnetized."

"Aw, get outta here, 'Soup.' Some welder's tired and is handing you a lot of malarkey."

"No, dammit, I tried it myself—the rod just won't take. Splatters, bubbles. Just won't take." Soup was in way over his head, and I was even worse-off. I never ran into that one before and it was obvious no one else had either, so I followed Dan and "Soup" to the Boiler House for the education.

Sure enough, the rod splattered and bubbled all over the place and made a lousy weld, if you could call it a weld at all. The pipe was so thoroughly magnetized it almost snatched a pocket knife right out of my hand.

"Change the polarity of the welding machine," I suggested, trying to act intelligent.

Same thing—the rod still bubbled and splattered.

Well, as you might expect, where there's a knot anywhere in the refinery, the Old Man is not going to be far away. He came strolling in, like the old bird dog he is.

"Soup" shifted his chew and repeated his hard-luck story, offering to take the Old Man up on the scaffolding and show him.

"'Soup,' I'm not about to climb that scaffold. I can see you've been a foreman too long now if you've forgotten how to demagnetize a piece of steel."

"I didn't forget—I never knew how in the first place," "Soup" wailed. Dan and me, we just waited for the lesson I knew was coming.

"What kind of engineers do you call yourselves? Any punk who was ever exposed to elementary electricity and magnetism can demagnetize that pipe," the Old Man yelled. I nodded my head but he might as well have been talking about nuclear fission.

"What kind of welding machine do you have here? D.C.? Good. Now just take the electrode lead and wrap it six or eight times around the pipe. If that doesn't do it, then wind the lead in the opposite direction." The Old Man stalked out so we could feel silly in private.

Now, me, I'm an electrical idiot, but I could vaguely remember something about how you magnetize a piece of iron with a coil, so it figured that we ought to be able to demagnetize it the same way.

We all climbed up while the welder wrapped his lead around the pipe and started to weld. The first try was no good, so we reversed the windings. Everything smoothed right out and that rod flowed on the bevel of the pipe just like honey on a biscuit.

Right now I'm hanging around as many welding jobs as I can, trying to find another piece of magnetized pipe so I can ask, "What kind of an engineer do you call yourself, anyway?"

"Soup, I'm not about to climb that scaffold."

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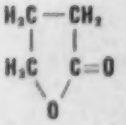


f.p. −44°C, b.p. 204°C, flash pt. 209°F. Soluble in water, alcohols, benzene, etc.

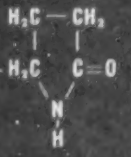
SOLVENT:

for polyacrylonitrile, cellulose acetate, polystyrene, shellac, etc. Selective solvent for acetylene in gas streams. Solvent in paint removers and petroleum processing.

OTHER USES:

Chemical intermediate for aliphatic and cyclic compounds. Cellulose acetate swelling agent for films and fibers.

2-PYRROLIDONE



m.p. 25°C, b.p. 245°C, flash pt. 280°F. Soluble in water, alcohols, benzene, etc.

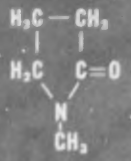
SOLVENT:

for polymers, Chlordane, DDT, d-sorbitol, glycerine, iodine, and sugars.

POLYAMIDE CONDENSATION POLYMER:

Polymerizes to a high molecular weight, linear, nylon-like polymer, $[NHCH_2CH_2CH_2CO]_n$.

N-METHYL-2-PYRROLIDONE



f.p. −24.8°C, b.p. 202°C, flash pt. 204°F. Soluble in water, alcohols, amines, ketones, etc.

SOLVENT:

for acrylonitrile polymers and copolymers. Spinning agent for polyvinyl chloride solutions. Dissolves 39 times its own volume of acetylene from natural gas streams. Solvent for agricultural chemicals...phenyl mercuric acetate, 2,4-D, etc.

SPECIAL SOLVENT USE:

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From Research to Reality

(To obtain more data on advertised products see page 142)

Do You Know These Words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help both administrators and operating men keep abreast of technical names and processes in the petrochemical field.

Methyl Methacrylate

Methyl methacrylate, pronounced "**meth**-ihl meth-**ack**-rill-ate," is a petrochemical of some years standing, being the monomer (basic polymeric unit) used for the production of such famous "acrylic" plastics as "Lucite" and "Plexiglas." It is a colorless liquid, slightly lighter than water per unit volume, and boils at about the same temperature, but freezes well below it. Unless stabilized by addition of an inhibitor before shipment, it polymerizes spontaneously.

Methyl methacrylate is chiefly used for making acrylic resins, as mentioned, although solutions and lower (liquid) polymers find use as cements, coating materials, etc. The solid methacrylate resins are thermoplastic, transparent, dimensionally stable, rigid, and (being originally colorless) may be colored as desired. Uses include airplane windshields and cowlings, display fixtures, illuminated medical instruments, decorative panels, containers, automobile parts, dentures, edge-lighted radio parts, signs, lenses, and others.

Methyl methacrylate has the formula $CH_2{:}C(CH_3){\cdot}COOCH_3$. It is produced commerically by the reaction of acetone ($CH_3{\cdot}CO{\cdot}CH_3$) with hydrogen cyanide (HCN), the intermediate $CH_3{\cdot}C(CH_3)(OH){\cdot}CN$ then being acidified with surfuric acid to yield methacrylic acid [$CH_2{:}C(CH_3){-}{\cdot}COOH$]. This is then esterified (esters being the reaction products of organic acids and alcohols) with methanol (CH_3OH) to yield methyl methacrylate. The three intermediates—acetone, hydrogen cyanide, and methanol—are all petrochemicals. Acetone is derived from propylene (via isopropyl alcohol), hydrogen cyanide from natural gas and ammonia (itself a natural-gas or reformate-hydrogen derivative), and methanol from natural gas.

Methyl methacrylate is a real tonnage petrochemical; announcements indicate that the capacity of present and planned plants may soon approach 80,000-100,000 ton/year. It is interesting to note how this "war baby" (World War II) has found such a prominent place in the modern plastics picture.

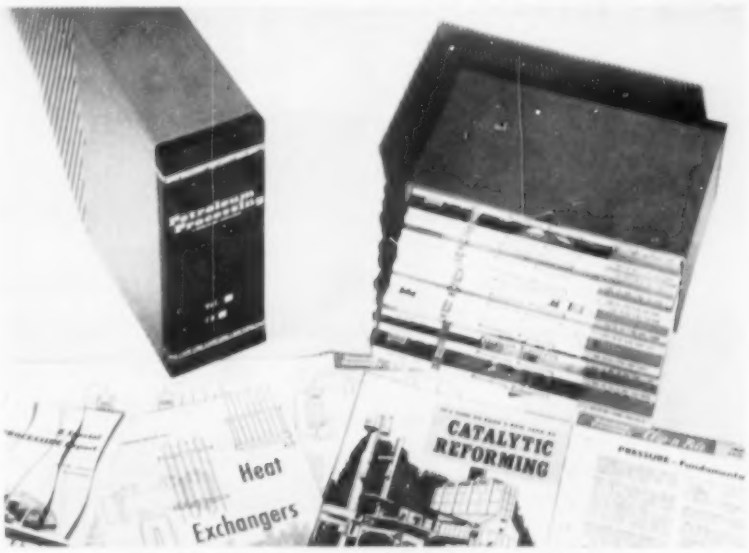
Cyclohexanone

Cyclohexanone, pronounced **"sigh**-klo-**heck**-sah-known," has the formula $C_6H_{10}O$—a cyclohexane ring in which one carbon atom is attached to an oxygen radical instead of to two hydrogen radicals. This means that the compound normally behaves like a ketone (compound containing a -CO- group); indeed, it has an acetone-like odor. Cyclohexanone is a clear, colorless-to-pale-yellow liquid which is nearly as heavy as water, per unit volume, but which boils well above it.

This compound is both a versatile solvent and a unique chemical intermediate. An excellent solvent for rubber, resins, cellulose nitrate, fats, oils, and dyes, it is used in many formulations containing these materials—lacquers, varnishes, leather finishes, vinyl compositions, rubber-base paints, paint removers, printing inks, adhesives, etc. As a chemical intermediate it is employed in resins, insecticides, herbicides, rubber accelerators, pharmaceuticals, and various "telomers" (polymers such as polyethylenes in which cyclohexanone groups act as terminal groups for the molecular chains).

Cyclohexanone is produced by the catalytic oxidation of cyclohexanol ($C_6H_{11}OH$), which in turn is produced by the catalytic hydrogenation of phenol (C_6H_5OH). As mentioned previously in this series (PETROLEUM PROCESSING, Sept., 1953, p. 1354), phenol is itself a petrochemical, being produced in a variety of ways from catalytic-reformate benzene.

Cyclohexanone is not one of the glamorized petrochemicals, such as polyethylene or nylon, but it is a highly useful one, being a chemical with many valuable properties. This is the reason that many of its uses are in connection with new materials (resins, etc.) and end products, and explains why continued growth is quite probable.



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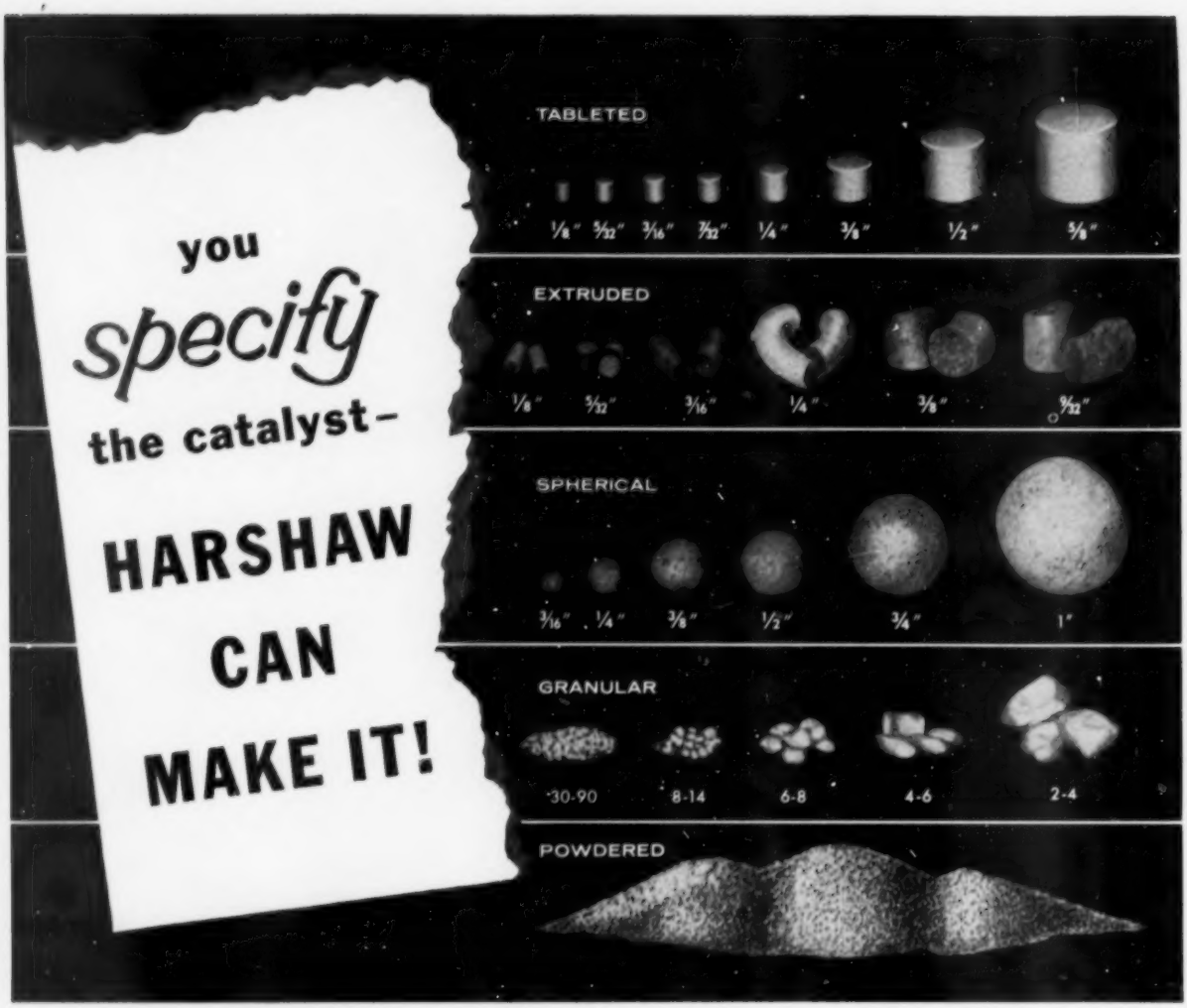

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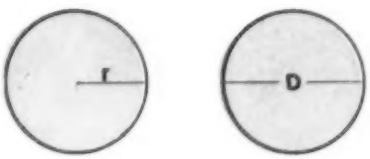
(To obtain more data on advertised products see page 142)

SPHERICAL TANK CAPACITIES (Completely Full)

D (FEET)	TOTAL VOLUME CU FT	GAL	BBL	D (FEET)	TOTAL VOLUME CU FT	GAL	BBL
1	0.524	3.88	0.093	36	24,429	180,980	4,351.0
2	4.189	31.03	0.746	37	26,522	196,490	4,723.8
3	14.14	104.8	2.518	38	28,731	212,850	5,117.3
4	33.51	248.3	5.968	39	31,059	230,100	5,531.9
5	65.45	484.9	11.66	40	33,510	248,260	5,968.4
6	113.10	837.9	20.14	41	36,087	267,350	6,427.4
7	179.59	1,330	31.99	42	38,792	287,390	6,909.2
8	268.08	1,986	47.74	43	41,630	308,420	7,414.7
9	381.70	2,828	67.98	44	44,602	330,440	7,944.1
10	523.60	3,879	93.26	45	47,713	353,480	8,498.2
11	696.91	5,163	124.13	46	50,965	377,580	9,077.4
12	904.78	6,703	161.15	47	54,362	402,740	9,682.4
13	1,150.3	8,522	204.89	48	57,906	429,000	10,314
14	1,436.8	10,644	255.90	49	61,601	456,370	10,972
15	1,767.1	13,092	314.75	50	65,450	484,890	11,657
16	2,144.7	15,889	381.99	51	69,456	514,570	12,371
17	2,572	19,055	458.10	52	73,622	545,430	13,113
18	3,054	22,626	543.95	53	77,952	577,510	13,884
19	3,591	26,604	639.60	54	82,448	610,820	14,685
20	4,189	31,033	745.92	55	87,144	645,610	15,521
21	4,849	35,924	863.65	56	91,953	681,240	16,378
22	5,575	41,302	992.97	57	96,967	718,380	17,271
23	6,371	47,200	1,134.7	58	102,160	756,860	18,196
24	7,238	53,623	1,289.2	59	107,540	796,680	19,153
25	8,181	60,609	1,457.1	60	113,100	837,890	20,144
26	9,203	68,181	1,639.1	61	118,850	880,480	21,168
27	10,306	76,352	1,835.6	62	124,790	924,490	22,226
28	11,494	85,154	2,047.2	63	130,920	969,950	23,319
29	12,770	94,607	2,274.4	64	137,530	1,018,900	24,495
30	14,137	104,730	2,517.9	65	143,790	1,065,300	25,611
31	15,599	115,570	2,778.3	66	150,530	1,115,200	26,811
32	17,157	127,110	3,055.8	67	157,480	1,166,700	28,049
33	18,817	139,410	3,351.4	68	164,640	1,219,700	29,323
34	20,580	152,470	3,665.5	69	172,010	1,274,300	30,636
35	22,449	166,310	3,998.4	70	179,590	1,330,500	31,987

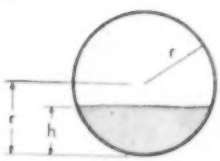
How To Figure Spherical Tank Volumes

Full Tank



$$V = 4/3\pi r^3 = 4.18879\ r^3$$
$$= 0.523498\ D^3$$

Partly Full Tank



$$V = (\pi h^2/3)\ (3r - h)$$

Note: When h is greater than r, subtract the computed volume from total sphere volume to obtain liquid volume.

Conversion Factors: 1 cu ft = 7.48052 gal = 0.17811 bbl

For Tables on Horizontal Tanks Turn Page . . .

HORIZONTAL CYLINDRICAL TANK CAPACITIES (Completely Full)

D (FEET)	UNIT VOLUME / ft of length CU FT	GAL	BBL
1	0.785	5.872	0.1398
2	3.142	23.504	0.5596
3	7.069	52.888	1.2591
4	12.566	94.009	2.2381
5	19.635	146.88	3.4972
6	28.274	211.50	5.0359
7	38.485	287.89	6.8546
8	50.266	376.02	8.9528
9	63.617	475.89	11.331
10	78.540	587.52	13.989
11	95.033	710.90	16.926
12	113.10	846.03	20.144
13	132.73	992.91	23.641
14	153.94	1,151.5	27.418
15	176.72	1,321.9	31.475
16	201.06	1,504.1	35.811
17	226.98	1,697.9	40.428
18	254.47	1,903.6	45.324
19	283.53	2,120.9	50.505
20	314.16	2,350.1	55.950

NOTE: Assume flat ends on tanks

How To Figure Tank Volumes

Full Tank

$V = LA = L\pi r^2 = L\pi D^2/4$

Partly Full

$V = LA$, where $A = (4h^2/3)\sqrt{(2r/h)—0.608}$

(This equation is a close approximation, adequate for estimating purposes.)

Notes: When h is greater than r, subtract the computed area from the total cross-section area of the tank. Multiply this liquid area by the tank length to obtain volume of liquid.

Conversion Factors:

1 cu ft = 7.48052 gal = 0.17811 bbl

HORIZONTAL CYLINDRICAL TANK VOLUMES (Partly Full)

Unit Volume (gal/ft of length)

Dia. of Tank, Ft.	DEPTH OF LIQUID, IN. 3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51
1	1.15	2.94	4.73	5.88													
1½	1.45	3.86	6.61	9.36	11.77	13.22											
2	1.70	4.60	8.05	11.75	15.45	18.90	21.80	23.50									
2½	1.91	5.23	9.27	13.72	18.36	23.00	27.45	31.49	34.81	36.72							
3	2.12	5.79	10.34	15.43	20.85	76.44	32.03	37.45	42.54	47.09	50.76	52.88					
3½	2.28	6.31	11.31	16.97	23.07	29.46	35.99	42.51	48.90	55.00	60.66	65.66	69.69	71.97			
4	2.45	6.78	12.20	18.38	25.10	32.20	39.54	47.01	54.47	61.81	68.91	75.63	81.81	87.23	91.56	94.01	
4½	2.60	7.22	13.04	19.68	26.97	34.72	42.80	51.08	59.49	67.90	76.18	84.26	92.01	99.30	105.94	111.76	116.38
5	2.75	7.64	13.82	20.91	28.72	37.06	45.82	54.88	64.11	73.45	82.78	92.01	101.07	109.83	118.17	125.98	133.07
5½	2.89	8.04	14.56	22.07	30.37	39.28	48.65	58.39	68.42	78.59	88.87	99.14	109.31	119.34	129.08	138.45	147.36
6	3.02	8.42	15.26	23.17	31.92	41.36	51.32	61.71	72.45	83.41	94.54	105.76	116.98	128.11	139.07	149.81	160.20
6½	3.15	8.78	15.94	24.21	33.41	43.34	53.86	64.87	76.27	87.97	99.90	111.97	124.12	136.27	148.34	160.27	171.97
7	3.26	9.12	16.57	25.24	34.85	45.24	56.29	67.87	79.91	92.30	104.98	117.85	130.87	143.95	157.03	170.05	182.92
7½	3.43	9.46	17.20	26.20	36.21	47.05	58.61	70.75	83.39	96.43	109.81	123.46	137.28	151.22	165.25	179.27	193.21
8	3.50	9.79	17.80	27.13	37.52	48.81	60.84	73.52	86.73	100.39	114.44	128.79	143.40	158.17	173.07	188.01	202.95
8½	3.61	10.10	18.37	28.01	39.00	50.49	62.99	76.18	89.94	104.20	118.89	133.92	149.25	164.81	180.53	196.36	212.25
9	3.71	10.39	18.94	28.90	40.03	52.14	65.09	78.74	93.04	107.87	123.17	138.87	154.89	171.19	187.71	204.37	221.15

Dia. of Tank, Ft.	DEPTH OF LIQUID IN. 54	57	60	63	66	69	72	75	78	81	84	87	90	93	96	102	108
1																	
1½																	
2																	
2½																	
3																	
3½																	
4																	
4½	118.98																
5	139.25	144.14	146.89														
5½	155.66	163.17	169.69	174.84	177.73												
6	170.16	179.60	188.35	196.26	203.10	208.50	211.52										
6½	183.37	194.38	204.90	214.83	224.03	232.30	239.46	245.09	248.24								
7	195.60	207.99	220.03	231.61	242.66	253.05	262.66	271.33	278.78	284.64	287.90						
7½	207.03	220.68	234.06	247.10	259.74	271.88	283.44	294.28	304.29	313.29	321.03	327.06	330.49				
8	217.85	232.62	247.23	261.58	275.63	289.29	302.50	315.18	327.21	338.50	348.89	358.22	366.23	372.52	376.02		
8½	228.12	243.95	259.67	275.23	290.56	305.59	320.28	334.54	348.30	361.49	373.99	385.48	396.47	406.11	414.38	424.48	
9	238.05	254.75	271.53	288.19	304.71	321.01	337.03	352.73	368.03	382.86	397.16	410.81	423.76	435.87	447.00	465.51	475.90

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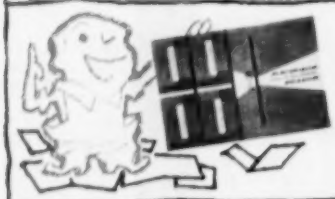
THE CASE OF THE PERIODIC PUMPING PROBLEM AND THE PATIENT PLANT ENGINEER

"... ub glub bedubtub
(this situation's becoming impossible)," glubbled Barney, the patient plant engineer.

"Ub tub ud ub tub ud ub tub
(I've tried and I've tried and I've tried)," bubbled Shorty, his faithful, conscientious assistant,
"Bud dub pubs wud hubtub dub slubb
(But the pumps won't handle the sludge)—it ruins them every time."

"Wub, subtub's *gub* tub bub dub
(Well, something's *got* to be done)," answered Barney. "Or, *I'll* lose my *patience* AND YOU'LL LOSE ... well, you'll be an *ex-faithful, ex-conscientious* assistant plant engineer."

With that, Shorty stubbled away ... in the direction of his office and catalog files.

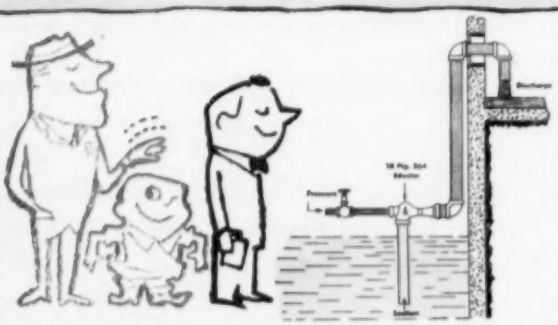


"I've got it," shouted Barney. "It says either an SK Jet Eductor or Syphon is good for pumping liquids where solids or semi-solids must pass through the apparatus and is ideal for use where pumping is periodic."

So he called in his nearest SK Sales Engineer who made an on-the-spot survey of the situation and, because of certain special considerations, recommended the use of an SK Fig. 264 Water Jet Eductor.

PATIENCE REWARDED

It paid to be patient. Now, the recurring drainage problem has been solved, simply and inexpensively. The SK Fig. 264 Water Jet Eductor uses pressure liquid, entering the eductor through a nozzle, to create a vacuum in the line which causes the suction liquid to flow up into the body of the eductor where it is entrained and discharged. Solids and semi-solids present no problem. Since there are no moving parts and the eductor is self-priming, the jet is ready to operate when required.



MORAL:

Get acquainted with all types of SK Jet Apparatus. Send for a copy of Condensed Bulletin J-1. Make use of a qualified specialist, your nearest SK Sales Engineer.

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JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin 10-EA.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

PERSONALS

William W. Ridenour has been promoted to superintendent of lubricants and process products at General Petroleum Co.'s Vernon facility. He was process products plant foreman.

D. G. Baldwin has been made lubricants coordinator at Vernon. He was previously grease, lube and drum plant superintendent.

Ralph D. Beck has been appointed civil engineer at the Torrance refinery, succeeding **L. E. Battelle,** who retired recently. Beck has held the positions of draftsman-supervisor and assistant civil engineer.

William B. Plummer has retired as president of Indoil Chemical Co., subsidiary of Standard Oil Co. (Ind.) **Jay H. Forrester** has succeeded him, but will become president of Amoco Chemicals Co. when that firm takes over Indoil and Pan American Chemicals Corp. later this year. Amoco is the former Hidalgo Chemical Co.

Plummer has been with Standard for 26 years. He was in the development and patent department and the chemical products department before becoming Indoil's president in 1949.

ESSOMAN MOVES TO CARTER—Dr. Carl O. Tongberg, formerly vice-president and director of Esso Research and Engineering Co., has joined Carter Oil Co. as a vice-president and director. He will take charge of research Carter carries on for producing affiliates of Jersey Standard.

L. A. Curran has been appointed assistant vice-president-manufacturing of Aurora Gasoline Co. He was formerly general manager of refining operations. This post has been assumed by **P. A. Blasco,** who was assistant general manager of refining operations.

T. J. Oleszko has moved from operations superintendent to assistant manager of operations.

Harry Murphy has been promoted from day foreman of the cracking plant to operations superintendent. His successor as day foreman is **Russell Murphy,** who was cracking plant foreman.

Five processing superintendents have been named for Tidewater Oil Co.'s new refinery at Wilmington, Del.

Raymond M. Camp, who was formerly superintendent of alkylation and isomerization at the Avon, Calif., refinery.

Lloyd E. Forbes, previously foreman of the Avon catalytic cracking plant.

M. David Haynes, who was chief process design engineer at the Bayonne refinery, no longer owned by the company.

Robert M. Hunt, formerly supervisor of the Bayonne paraffin and lubricating department.

E. L. Raun, previously process superintendent and acting mechanical superintendent at Bayonne.

The new refinery's superintendent of engineering, maintenance and construction will be **Robert B. Beattie,** who was coordinator on the refinery project.

R. S. Stanfield, formerly Bayonne's chief engineer, has been named refinery representative.

Dr. Arthur W. Lewis has been appointed superintendent of technology. He headed the research laboratory at Bayonne.

Reese H. Taylor has been elected chairman of the board of Union Oil Co. of California. Taylor is also chief executive of the company.

W. L. Stewart, Jr., formerly senior vice-president, has been elected vice-chairman of the board. **A. C. Rubel,** who was vice-president in charge of exploration and production, has been elected president of the company.

Director of Union's research, **F. L. Hartley,** has been named vice-president.

Dr. Charles L. Fleming has been elected a vice-president and director of Esso Research and Engineering Co. He succeeds **Dr. Carl O. Tongberg,** who has joined Carter Oil Co.

Fleming's post of director of the products research division has been taken by **Dr. Miller W. Swaney,** formerly director of the Enjay Laboratories. He has been succeeded at Enjay by **Elfried F. H. Pennekamp,** who moves up from assistant director.

Harold J. Rose has been appointed coordinator of chemicals research. He has held this position on a temporary basis.

Robert M. Shepardson has been made manager of a division within Jersey Standard's marketing coordination department. His former post of deputy coordinator of petroleum products and medical research at Esso Research has been taken over by **Dr. John G. McNab. Dr. Neil V. Hakala** has assumed McNab's old job as associate director of the products research division.

Hakala's successor as assistant director is **George A. Rial,** who was a staff engineer in the engineering group of the manager's office.

F. A. Upson has been appointed chief engineer, general engineering department, of Standard Oil Co. (Ind.) at Whiting, Ind. He was assistant chief engineer in the process engineering division, and this post has been taken by **Otis J. Thompson. Wilbert J. Buxton** succeeds Thompson as head en-

gineer in charge of the lube oil and asphalt section.

Upson has taken charge of the process engineering division. He replaces **Harold M. Romig,** who has retired.

In the technical service divisions of the Whiting refinery, **Robert O. McKinley, Robert J. Austin,** and **John H. Lovett** have been made section leaders. McKinley will be leader in the refinery economics division, Austin in heavy oils, asphalt and ammonia division, and Lovett in the light oils division.

William L. Nemac, Robert H. Crowther, and **Francis J. Citek** have been named group leaders. Nemec will be in refinery economics, Crowther and Citek in light oils.

Robert W. Klipp has been appointed general foreman of the analytical laboratory.

John E. Ford, Jr., has been elected chairman of the board and chief executive officer of the U.S. Oil & Refining Co., Tacoma, Wash. One of the founders of the company, Ford has been acting as an advisor to the firm for the past 18 months.

Mr. Ford

He has been connected with Sinclair Refining Co., M. W. Kellogg Co., and Houdry Process Corp. over the past 20 years.

Warren Wilson has become head of a project to evaluate safety policies and practices of Esso Standard Oil Co.'s East Coast refineries. He was assistant general superintendent at Esso's Bayonne refinery. This post has been filled by **Charles Swoope,** formerly of the East Coast technical service division.

Selby Harney succeeds Swoope, and his post, assistant general superintendent at Bayway, has been assumed by **Bill Sheridan.**

Sheridan leaves the job of employe relations department head to **Douglas Bates,** who was serving in the assistant's post. This has been taken by **John Ashbaugh,** who moves from head of the communications and research division of the department.

Bob Finigan, head of light ends department at Bayway, has been transferred to the Everett refinery as mechanical superintendent. His successor at Bayway is **Al Connollee,** who was supervisor of the No. 1 catalytic cracking plant.

L. C. Shultz has retired from Shell Oil Co. to open offices in Houston as a consultant in instrumentation. Prior to retirement he was instrument engineer in charge of new construction projects.

Shultz was a charter member of the Houston Instrument Society, which later became the Houston Section of the Instrument Society of America. He is now vice-president of the Section.

J. A. Anderson, Jr., has been promoted to research associate in the research and development division of Humble Oil & Refining Co.'s Baytown refinery.

E. W. Bowerman has been made assistant division head in research and development. Bowerman holds a B.S. in chemical engineering from South Dakota School of Mines and a Ph.D. in chemistry from Ohio State University.

Anderson received a chemical engineering B.S. from the University of Illinois and an M.S. from Pennsylvania State University.

B. R. Dorsey has been named coordinator in Gulf Oil Corp.'s manufacturing department, in Pittsburgh. He was formerly supervisor, scheduling and cost control in the department, and he succeeds the late E. J. Kirberg.

Dorsey's last post in operations was as manager of the Venezuela Gulf Refining Co.'s refinery at Puerta La Cruz. He held this job from 1948 until his transfer to Pittsburgh in 1955.

He holds a chemical engineering degree from the University of Texas, which he received in 1940.

Norman G. Bach, supervisor of engineering services for Monsanto Chemical Co., at Texas City, has been named president of the newly organized American Association of Cost Engineers.

W. J. Anderson has joined the staff of Standard Oil Co. (Ind.) in the general engineering department, projects division, as a head engineer. He was formerly with Commonwealth Oil Refining Co. as an executive assistant.

Dr. Dayton H. Clewell has been named manager of Socony Mobil Oil Co. laboratories, succeeding **Dallas R. Lamont,** who continues as director of research. Clewell was previously manager of Magnolia Petroleum Co.'s field research laboratories at Dallas. In his new post he will be in charge of all Socony laboratories—at Dallas, Paulsboro, and Brooklyn, N.Y.

Dr. C. Ivan Alexander, supervisor of exploration research division at the Dallas laboratories, has succeeded Clewell there.

Jay Olvey has been made assistant refinery manager at the Cheyenne plant of Frontier Refining Co. **Hallis Spencer** has become process foreman at the No. 2 plant, and **Tom A. Kirk** has taken the same post at No. 1. **G. Palmer Long** has been made maintenance and construction superintendent.

Francis G. Hester has been made maintenance and engineering superintendent of Great Northern Oil Co.'s Pine Bend, Minn., refinery. He has been with the company since 1955 and served as chief engineer and assistant maintenance superintendent.

Mr. Hester

Before joining Great Northern Hester was chief engineer and maintenance superintendent for Great Southern Chemical Corp., Corpus Christi, Tex.

Dr. Warren L. Jensen has been made director of the newly created petroleum products division in the development and research department of Continental Oil Co. at Ponca City. He was formerly director of the central research division.

D'Arcy Shock, formerly supervising research chemist, has succeeded Jensen in the central research division.

David B. Burrows, who was supervising research engineer, has been promoted to director of the newly formed technical services division.

Horace E. Luntz has been appointed technical assistant to the manager of development and research.

Five managers have been appointed for six new operating divisions in a reorganization of Sinclair Refining Co.'s manufacturing department:

R. E. Howe, processing division, who will advise on improving operations of existing equipment and approve process design work in future projects.

J. E. Bell, engineering and maintenance division, who will direct engineering for existing refinery equipment and approve engineering on future projects.

G. F. Kuhn, refinery production division, who will handle crude and

project evaluations, cost studies, and study of long-range projects dealing with overall department economics.

K. A. Beach, asphalt and chemicals division, who will supply asphalt products and chemical products to the respective departments and approve specifications on all products except lubes and greases.

A. D. Hill, lube oil production division, who is responsible for all lube oil and wax matters, approval of all lubricating and grease formulations, and direction of barrel house and lab operations.

Kuhn will also manager the sixth division, light oil production, until a permanent manager is named.

Harry A. Jackson, recently retired from Tidewater Oil Co., has been elected president of American Petrofina, Inc., an affiliate of Petrofina of Belgium. Jackson was with Tidewater for more than 35 years, ending in the position of vice-president and general manager of the eastern division.

Mr. Jackson

During this time he was also president of Seaside Oil Co., California subsidiary of Tidewater; and a vice-president and director of Tide Water Tankers, Inc., the Flying -A- Co., Hemisphere Transportation Corp., and Tide Water-Iran, Ltd.

Herbert Spencer, founder and former president of the Asphalt Institute, has retired from the Institute. In his honor, a $3000 fellowship has been established at Cornell University by Esso Standard Oil Co., where he was employed from 1912 to 1941.

Mr. Spencer

His interest in asphalt began at the outset of the Automobile Age, the first decade of this century. He joined the old Standard Oil Co. of New York in 1908 as a consulting engineer on specifications for asphalt and its use in highway construction. Four years later he joined Esso Standard Oil Co. The Asphalt Institute was established in 1919, and in 1941 Spencer was named its first full-time president.

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You'll keep plant production and efficiency way up... practically eliminate costly downtime due to tube failure, with AIRETOOL Condenser Tube Maintenance equipment. Even at "turn-a-round" time, lost stream, time is kept to a minimum. Repair, removal and replacement of tubular equipment is accomplished faster, easier and at less cost, with AIRETOOL equipment on the job.

Don't wait... investigate all the advantages of AIRETOOL Condenser Tube Maintenance Equipment now. There's a precision built AIRETOOL tube maintenance tool for every type of tubular construction. See your nearest AIRETOOL Representative today... or write AIRETOOL MFG. CO., Springfield, Ohio, for information.

NEW INTERNAL TUBE CUTTER quickly removes damaged or leaky tubes. Cuts through steel or non-ferrous tube sheets to 4" thick. Air or electric driven motor.

NEW PUSH-TYPE INTERNAL TUBE CUTTER for non-ferrous tubes ⅝" to 1" O.D. cuts through tube sheets 1" to 4" thick. Operates on your own air or electric motor.

CONDENSER CLEANERS outside mounted, direct or gear driven. Powerful . . . fast . . . lightweight . . . for lightly scaled or completely plugged tubes. Built in flushing system cools drill, removes cuttings.

CONDENSER TUBE EXPANDERS parallel rolling, self-feeding, ball bearing thrust. Rolls tubes to uniform thickness, with maximum bonding.

AIRETOOL MIDGET CLEANERS for lightly scaled tubes. Small, powerful, excellent for cleaning small tubes with extremely short radii turns or hairpin bends.

Send for Bulletin #59, illustrating the complete new line of AIRETOOL Tube Cutters, cleaners, expanders, accessory and specialty tools.

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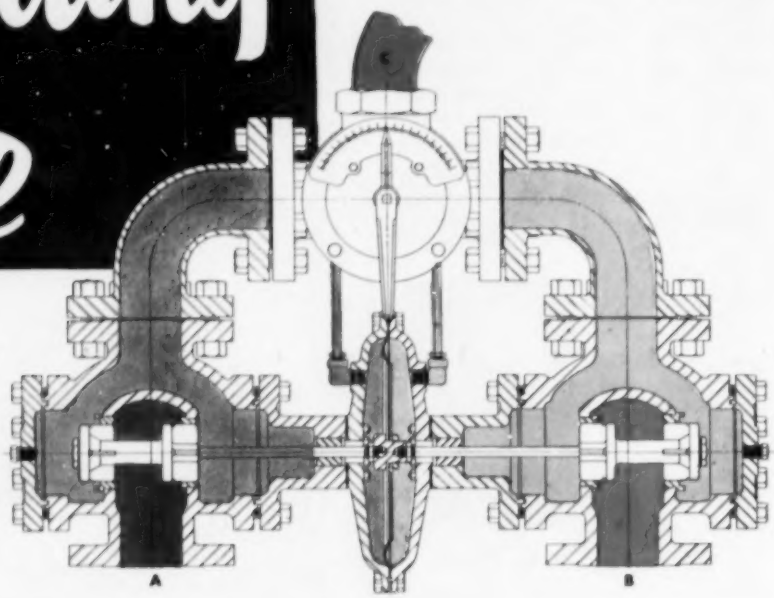
Blending Valve

AUTOMATICALLY BLENDS TWO FLUIDS IN ACCURATE DESIRED PROPORTIONS



LEGEND

FLUID A
Fluctuating Inlet Pressure

FLUID B
Fluctuating Inlet Pressure

FLUID A
Constant Equalized Reduced Pressure

FLUID B
Constant Equalized Reduced Pressure

FLUID C
Blended Fluid of Desired Characteristics

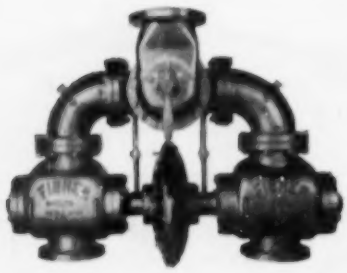
- **Eliminates necessity of measuring given quantities and batch agitation.**
- **No vapor loss in gasoline blending.**
- **Reduces blending process expense.**
- **Pointer and scale device affords simple method of accurately controlling percentages of inlet fluids to be blended.**
- **Successfully used for over 10 years.**

SPECIFICATIONS

Sizes Available—3" and 6" flanged iron or steel.

Capacities—30 to 900 gpm—{3" $C_v = 84$ / 6" $C_v = 275$

Accuracy—± 1%—Pressure rating 100 psi.



The Fisher Type 430 Blending Valve will accurately blend two liquids in any proportion, holding the blend ratio constant and independent of variation in pumping pressure by action of the equalizing pressure regulator. It is suitable for blending any fluids of moderate viscosity which do not carry suspended solids and which flow at relatively constant temperature. A great number have been installed in refineries and bulk plants for blending different grades of gasoline to obtain a higher octane grade.

The blending unit employs the principle of parallel metering of the fluids through two orifices whose rates of area may be varied, while at the same time holding the pressure drop across the orifices at the same value. Thus, the ratio of the two orifices areas is in direct proportion to the bleed or ratio of the two flowing streams.

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MARSHALLTOWN, IOWA • WOODSTOCK, ONTARIO

LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER Since 1880

S&J Reorganizes Operations

Reorganization of Shand & Jurs Co., Berkeley, Calif., has resulted in the formation of four principal divisions: sales, headed by E. E. Jurs; electrical products, with A. E. Jurs in charge; mechanical products, under P. C. Jurs; and the finance division in charge of Bruce G. McCauley. R. M. Young remains the firm's president.

Rapid expansion of the electronics equipment line has made it necessary to house the electrical products division in a new plant in Berkeley, releasing space in the main plant for expansion of the mechanical products division.

Bruce G. McCauley, who has just taken over the finance division was at one time a mechanical engineer with Standard Oil Co. of California. He has also been assistant purchasing agent for Curtis Manufacturing Co., professor of industrial engineering at the University of California, and a management engineer.

AIRBORNE CLASSROOM of Robertshaw-Fulton Controls Co.'s Fielden Instrument Division about to leave for Houston to conduct an intensive training session on new instruments for area representatives, Eggelhof Engineers. Ralph V. Coles (second from left) Fielden general manager, sees group off. Others are (l to r) Fred L. Maltby, director of engineering; Ralph M. Stotsenburg, sales manager; John A. Fairbank, product supervisor; company driver; and Joseph Philippi, product supervisor. Boxes contain instruments.

UOP Sets up Petrochemicals Unit

A new department at Universal Oil Products Co. will handle commercial application of petrochemical processes licensed by the company. The department will function under M. D. Gilchrist, process sales vice-president, with H. W. Grote directing its activities. Mr. Grote was formerly assistant manager of the research and development laboratories.

In another development at UOP, E. R. Kanhofer, formerly manager of the Riverside, Ill., facilities, has been named assistant to Col. J. C. Raaen, research vice-president.

Southwest Pipe Plant to Open

Seamless steel tubing and seamless steel pipe of ⅛ to 3-in. outside diameters will be available through a new company in the Houston area sometime in December. A plant is now being constructed by the company, Gulf States Tube Corp., near the town of Rosenberg, Texas, on a 37-acre tract. Gulf States is a subsidiary of Michigan Seamless Tube Co., South Lyon, Mich.

Steel alloys and steel-clad piping will also be produced in the plant. The tubing will be distributed throughout the southwest in oil, chemical, sulfur, and other industries. It can be produced to a wide variety of specifications, and an output of 12,000 tons a year is expected. The plant is one of 10 hot mill seamless steel producing facilities in the U. S., according to the company.

New Post Filled at SWECO

Philip Freneau has been appointed to the new position of chief project engineer in Southwestern Engineering Co.'s manufacturing division. He joins the Los Angeles company after a 10-yr affiliation with the Elliott Co. of Jeannette, Pa., where he was most recently chief engineer of the apparatus division.

Mr. Freneau is a mechanical engineering graduate of Cornell University and has specialized in the engineering of steam jet ejectors, condensers, and related equipment for the process industries.

Southwestern does engineering, construction and manufacturing for the process industries and recently took on the design and manufacture of steam jet ejectors and certain other specialty products.

Moorman Joins Consulting Firm

Joseph W. Moorman has been appointed midcontinent district manager for James P. M. O'Donnell, consulting engineer. Mr. Moorman will open offices for the company at Tulsa, Okla.

He was formerly associated with the M. W. Kellogg Co., and since 1947 has conducted his own practice as consulting engineer.

Johnson Is CEC Sales Director

William F. Johnson has been appointed director of sales of Consolidated Electrodynamics Corp. He succeeds Joseph F. Davidson, who has accepted the position of marketing vice-president of Arnoux Corp., Los Angeles manufacturers of electronic instrumentation.

Mr. Johnson

Johnson joined CEC in 1947 as a design engineer, became manager of application service in 1951, and for the past three years has been manager of sales operations. Before going to CEC he held engineering posts with Kaiser-Frazer Corp. and the Southern Pacific Co.

He is a graduate of the University of California with a B.S. degree in electrical engineering.

Monsanto Groups L.A. Sales

A new distribution center for Monsanto Chemical Co.'s marketing activities in southern California has opened. The office and warehouse,

consisting of about 60,000 sq ft of space, accommodates district sales representatives of the organic, inorganic, plastics and consumer products' divisions, as well as warehousing activity for all of Monsanto's products. This consolidates the company's activities in the Los Angeles area.

The new structure is located at 6670 East Flotilla St.

Sims Joins Catalytic Sales

Willis F. Sims has joined Catalytic Construction Co. as refinery sales representative for the southwest area. He has made his headquarters in Tulsa, Okla.

Mr. Sims was once refinery manager at Wichita Falls, Texas, for Panhandle Oil Corp., and was associated with Blaw-Knox Co. before joining Catalytic.

New Sales V-P at Delta

William V. Rathbone has been appointed vice-president of sales of Delta Tank Manufacturing Co., Baton Rouge. He was formerly executive vice-president of Parkersbury Rig & Reel Co.

Mr. Rathbone

A graduate of Lehigh University in 1926 with a degree in chemical engineering, Mr. Rathbone is currently president of the Oilfield Tank Manufacturers Association. He was associated with Standard Oil Co. of N. J. before joining Parkersbury 10 years ago.

Delta Tank is a wholly-owned subsidiary of General Gas Corp.

Personnel Changes

Jones & Laughlin Supply Division—William M. Douglas to Tulsa sales staff. Formerly sales manager of the Muskogee, Okla., district, now closed, Douglas will concentrate on petrochemical, refining, and allied fields in Tulsa and northern Oklahoma.

Fischer & Porter Co.—William C. Abbey to district sales engineer in the data reduction and automation division. He will work out of the Houston office. He was formerly with Manning, Maxwell, and Moore and has several years experience in instrumentation sales on the Gulf Coast.

Western Supply Co.—T. Deal Reese to special representative, with assignments in the refining, petrochemical, chemical and pipeline industries. He has resigned as vice-president and regional sales manager of Gulf Supply Co., Beaumont, and now has his headquarters at Western's offices in Houston.

Pollak & Skan, Inc.—Harry M. Betzig to this Chicago engineering firm as chief engineer of the newly formed process engineering division. He was formerly principal engineer for the Blaw-Knox Co. chemical plants division's Chicago office.

Baker & Co.—Bernard Seligman to technical sales representative, in Newark, N. J. He will work with new developments and applications in catalysts, especially precious metal catalysts. He was formerly senior research chemist with the company and helped develop the platinum catalyst used in reforming operations. At one time he was employed by The Texas Co. in the central research laboratory.

Davison Chemical Co.—Richard C. Mathews to field service engineer in the petroleum catalyst department, Houston office. He succeeds John Benedict, recently transferred to New York.

Babcock & Wilcox Co.—Frank T. Murphy, St. Louis district manager, has retired; J. N. Rogers to sales representative in charge of Mr. Murphy's office.

ALCO Products, Inc.—William L. Wilcox, W. W. Power, William O. Rogers, and John A. Langford to the sales force. The first three are in the southwest, the last-named in Los Angeles.

Lunkenheimer Co.—Charles W. Burrage, manager of engineering sales since 1950, has retired.

Cooper-Bessemer Corp.—R. F. Bartlett to manager of the Dallas branch. He has been with the company since 1934 working in the field application of engines and compressors.

Trane Co.—Donald E. Jaekle to the Philadelphia sales office.

Hills-McCanna Co.—Edward H. Lund and Gordon J. Wagner to sales engineers; Lund is in Philadelphia, Wagner in New York City.

Carpenter Steel Co.—Wilburn J. Comerford to specialty products engineer with the Alloy Tube Division. He was formerly a field engineer for International Business Machines.

Branches, Distributors

Selas Corp. of America has opened a new regional office for its fluid processing division. Located in New York City's Chrysler Building, the office is headed by Gerald E. Mitchell, who has been sales representative in the Newark-New York sales district for the past 4½ years.

Fisher Governor Co. has appointed Crabbe & Stebbins Co. sales representatives in New York and surrounding territory. Fred Crabbe has been with Fisher since 1943, Jerry Stebbins since 1947. Lynn Maxwell and William Conway have joined Crabbe & Stebbins Co., Maxwell to work out of the New York office, Conway to head the Albany office. Both have had sales experience with Fisher.

Expansion, Transition

Wedgeplug Valve Co., has moved its operations to the Stockham Valves & Fittings plant at Birmingham, Ala. Wedgeplug is a Stockham affiliate. Move will increase facilities for company's production of non-lubricated steel plug valves. Address in Birmingham is 4000 Tenth Ave. North. P. O. Box 2592.

Solvent Service, Inc., has acquired accounts of the Lemont Chemical Co., Lemont, Ill., thus extending Solvent's operations to Indiana, Illinois, Wisconsin, Minnesota, Iowa, South Dakota, and Upper Peninsula and southwest sections of Michigan. The new midwest operation is based at East Chicago. Solvent Service specializes in chemical and hydraulic cleaning and descaling of industrial equipment.

Consolidated Electrodynamics Corp. has sold its 36% interest in ElectroData Corp. to the Burroughs Corp. ElectroData makes electronic computers.

Rockwell Manufacturing Co. has opened a gas meter research and development laboratory at Dubois, Pa., said to be the world's largest. Lab will permit company to run wear and endurance tests on diaphragms, complete meter mechanisms and gears, and to make comparative corrosion tests on materials.

SPECIALIZED PETROLEUM PROCESSING

for producers and refiners

PETRECO ELECTRIC DEHYDRATION

Petreco electric dehydration is an automatically controlled method for reducing the B.S. and W. content of crude oil to pipe line specifications. It is particularly adaptable for large central plant dehydrating systems and also is highly effective on low gravity crudes.

PETRECO SEDIMENT SEPARATION

Where producers utilize sub-surface hydraulic production pumps, it is essential that the power oil be clean, dry and free from fines, sediment, etc. Petreco Electric Sediment Separation removes such impurities from crude oil and delivers clean power oil.

PETRECO ELECTRIC DESALTING

Petreco pioneered electric desalting and is the recognized leader in this field. Petreco offers a choice of desalting vessels, to better handle varying volumes of crude. In every refinery where Petreco desalters have been installed, salt difficulties have been stopped.

PETRECO ELECTROFINING

Electrofining is a Petreco development and offers a revolutionary method for caustic washing, acid contacting, doctor treating and nitrogen base removal. Electrofining usually is a single-unit, one-pass, automatically controlled, continuous process.

PETRECO — BENDER SWEETENING

The Petreco Bender Process is utilized for sweetening gasoline, kerosine, jet fuel and No. 2 fuel. Sweetening is effected by converting mercaptans to disulphide by oxidation. The chemical cost is low, throughput rates are high, and catalyst can be rejuvenated at the plant.

PETRECO ELECTRIC LUBE-OIL TREATING

Petreco Lube Oil Treating provides continuous, automatically controlled acid treatment for lube oils and similar stocks. Treating takes place in a closed system, requiring much less tankage than conventional acid treaters. It saves acid, time, space and guesswork.

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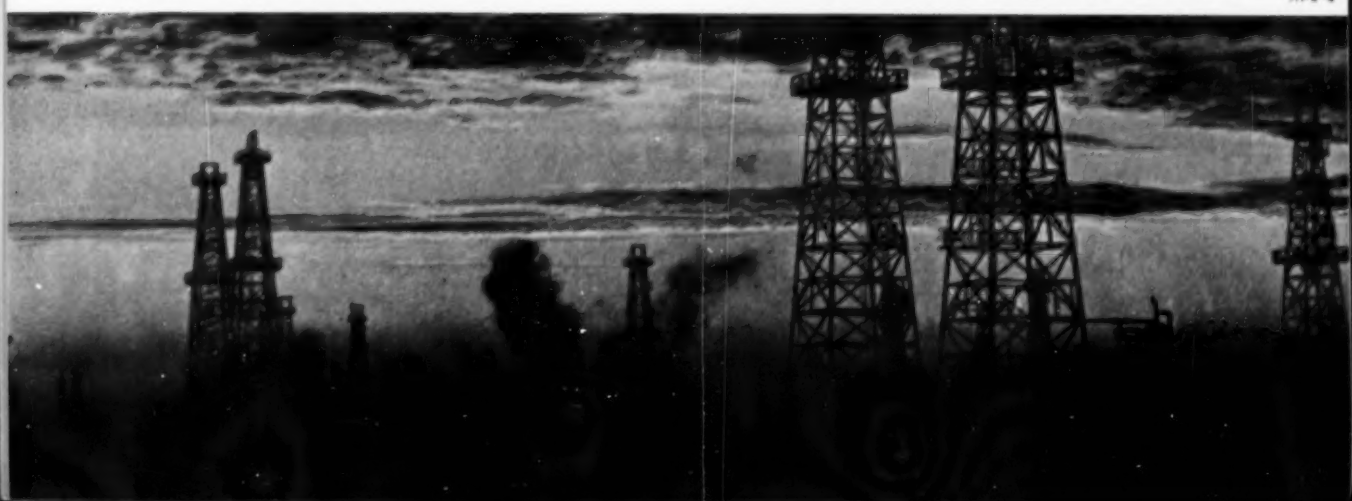

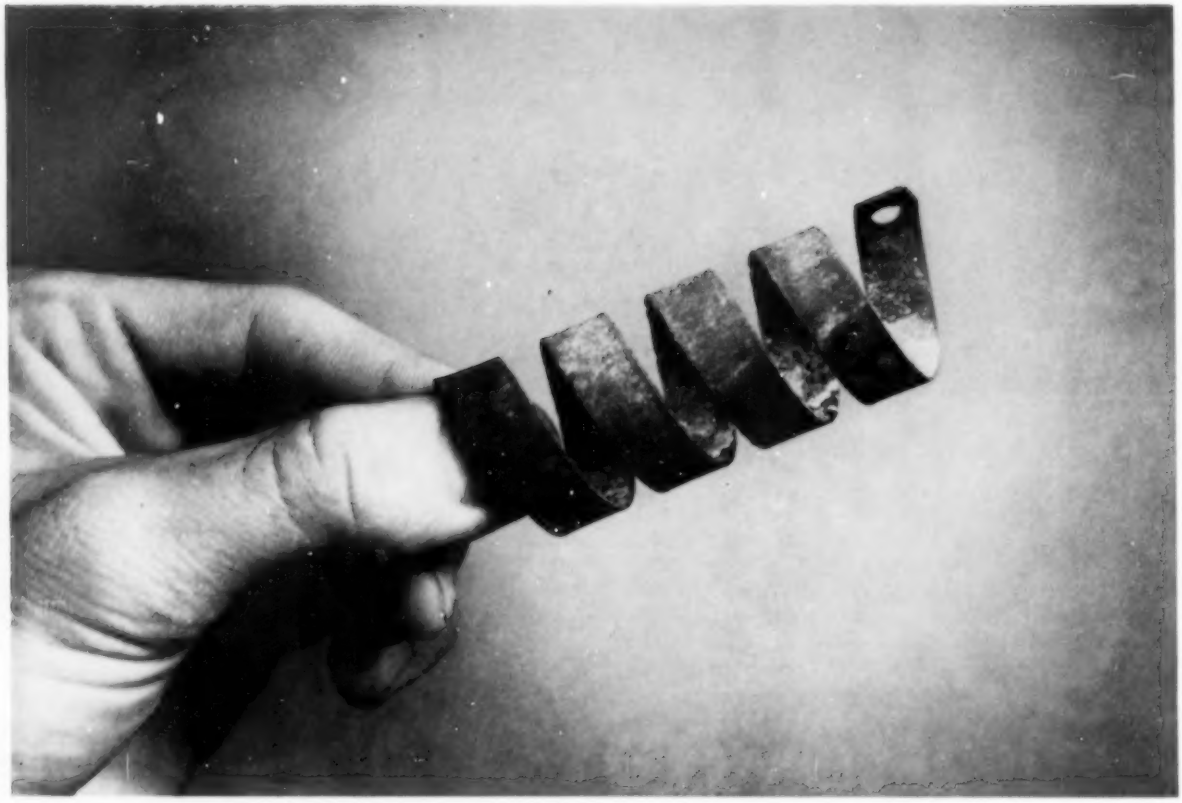

THIS STACK CONTROL element had to be removed from a domestic heating unit because of faulty operation caused by deposits. The non-metallic, ashless properties of Du Pont FOA-2 can help you reduce similar failures, and consequent service calls, to a minimum.

Many stack control failures can be prevented with this *ashless* additive

Du Pont Fuel Oil Additive No. 2 (FOA-2) can protect your distributors against many unprofitable service calls. Since it is a non-metallic, *ashless* additive, it burns completely, without leaving any significant trace of deposit to interfere with the operation of stack controls.

This ashless feature also means that heating oils stabilized with Du Pont FOA-2 will not contribute to deposits that cause shorting on the electrodes of the burner system. In this way, it helps to minimize ignition failures, too.

To prevent clogging of nozzles, screens and filters—another common cause of service calls costly to distributors—FOA-2 retards the formation of insoluble residues. And this stabilizing action is effective over unusually long storage periods.

FOA-2 also has an effective dispersant action which reduces the particle size of any residues that may form. And it helps to remove existing sludge deposits from the fuel system.

For best results, FOA-2 should be added to freshly prepared stocks at the refinery. It is economical to use because it is effective in low concentrations. Any of our sales offices listed below will be glad to supply you with the full details.

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New Thermal Cracking Process

. . . features continuous coke recovery

THERMAL AND CATALYTIC cracking of petroleum residua have been impractical because of the overwhelming amounts of coke made during the cracking reactions. For thermal cracking, the threat of coke limits process severity. For catalytic cracking, too much coke means too great a catalyst circulation rate and a gigantic coke burning facility.

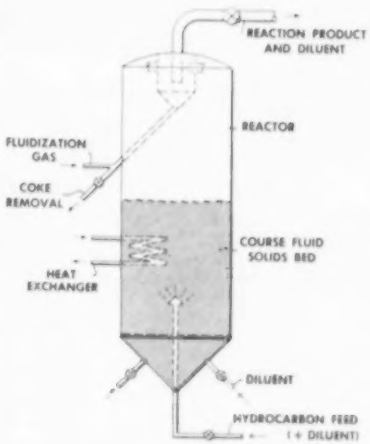
A new twist on thermal cracking by Esso Research & Engineering Co. (U.S. Patent No. 2,756,195) removes coke as it is made, not only eliminating the process severity limitation, but allowing the coke to be removed for further use.

The secret is a fluidized bed of dense, non-porous, abrasion-resistant, inert contact material on which coke is formed during the cracking operation. As the coke forms on the contact material, abrasive action grinds the coke off so that it can be blown into a separator, and recovered separately from the reaction products.

The fluidized bed does not circulate, but stays within the reactor shown above. Suitable materials for the fluidized bed include rounded sea sand, metal shot, ceramic beads, etc. Particle size is best at 150-500 microns, with a packed density of around 1.2-4.

Feedstock to the reactor can be reduced crude, vacuum residuum, clarified oil from catalytic cracking, pitch, visbreaker tar, etc. Very viscous feed can be cut with naptha, or preheated, prior to reaction.

Diluent gas, such as steam, recycle gas, or other inert or hydrocarbon gases, may be introduced at the bottom of the reactor, further diluting the feed. The diluent gas also helps in keeping the contact bed in a fluid state.



THERMAL REACTOR for cracking residua and recovery of coke.

Operating conditions may vary according to the desired product distribution, but temperatures are usually 900-1400°F and pressures 5-25 psig. The linear gas velocity in the reactor is kept at about 2-5 ft/sec, or at as high a velocity as possible without entraining the solid material in the contact bed.

Coke and product are separated by an internal cyclone at the top of the reactor. The coke is kept fluidized, to allow pneumatic movement to other locations, by the fluidization gas entering the coke removal line.

Reaction heat is supplied to the reactor by exchange coils, or any other suitable indirect heating means.

Process results are illustrated by the cracking of a 11.9°API South Louisiana vacuum residuum at a temperature of 1270°F. The upward gas velocity was 2.6 ft/sec, of which about 1.9 ft/sec was from steam diluent and the remainder from reaction product vapors. A sintered metal filter was used to separate the abraded coke from the product vapors going overhead.

Analysis of the solids (from the fluid bed) after a 3 hour run showed them to be 10.9 wt% coke and 0.2 wt% hydrogen. Material from the sintered metal filter analyzed 76.1 wt% carbon and 1.1 wt% hydrogen, the rest was ash and a little entrained sand. The filter material accounted for 60% of the total coke made, showing that the abrasion removal of coke from the reactor is practical.

About the Patents Listed

The following patents have been selected because of their interest to the petroleum processing industries. Included in this issue are patents from the Official Gazette of the U.S. Patent Office for July 17, 24, 31, Vol. 708, No. 3, 4, 5, and August 7, Vol. 709, No. 1, 1956.

You can obtain copies of patents for 25c each by writing directly to the Commissioner of Patents, Washington 25, D.C. Order by patent number.

PROCESSES AND METHODS

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
Absorption	olefins	mineral acid	Esso Research & Engineering Co.	2,755,297
Catalytic Reforming	hi-sulfur gasoline	hydrogen pretreatment	Universal Oil Products Co.	2,758,064
	hi-sulfur motor fuel	fluidized cat. & O_2-H_2O_2 regeneration	Esso Research & Engineering Co.	2,756,191
	hydrocarbons	CO in hydrogen recycle gas	Socony Mobil Oil Co., Inc.	2,756,190
	hydrocarbons	recycle gas moisture control	Socony Mobil Oil Co., Inc.	2,758,065
	hydrocarbons	regenerable, fluid, Pt cat.	Esso Research & Engineering Co.	2,758,063
	hydrocarbons	thermo-compression of recycle gas	Socony Mobil Oil Co., Inc.	2,756,192
	liquid hydrocarbons	hydrogen & catalyst with Mo, W or Ni	Gulf Research & Development Co.	2,755,228
	motor fuels	fluid catalyst & regeneration	Esso Research & Engineering Co.	2,756,187-9

Continued on p. 128

Patents

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
Cat Reforming (Cont.)	naphtha	catalyst already used for desulf.	Union Oil Co. of Calif	2,758,059
	naphthas	two stages, fixed-bed then fluid	Esso Research & Engineering Co.	2,758,062
Coating	metal	furfural resin	Sun Oil Company	2,755,204
Combining	mineral oil	oil-insoluble solid	Socony Mobil Oil Co., Inc.	2,758,085
Compacting	carbon black	dry, then wet tumbling	J. M. Huber Corporation	2,758,039
Condensation	aromatics	unsaturated hydrocarbons	Universal Oil Products Co.	2,758,140
Contacting	solids & liquids	moving solids catalyst bed	Socony Mobil Oil Co., Inc.	2,758,070
Conversion	hydrocarbons	pebble heater	Phillips Petroleum Co.	2,755,320
Corrosion Control	sour crude tanks	NH_3 evolution from ammonium compounds	Pure Oil Company	2,755,166
Cracking	cracked residual oil	thermal process to increase aromatics	Phillips Petroleum Co.	2,756,186
	reduced crude	fluid sand & abrasive coke removal	Esso Research & Engineering Co.	2,756,195
Crystallization	liquid components	freezing and immiscible inorganic salt	Esso Research & Engineering Co.	2,757,126
Dehydration	process recycle gas	drying zone	Socony Mobil Oil Co., Inc.	2,755,230
Dehydrochlorination	polychlorocyclohexanes	controlled vaporization	Ethyl Corp.	2,756,813
Desulfurization	crude oils	catalytic-hydrogen reaction	British Petroleum Co., Ltd.	2,755,225
	hydrocarbons	adsorbent impregnated by Fe-group carbonyl	Esso Research & Engineering Co.	2,756,182
	mineral oil	unsaturated nitrile	Sun Oil Co.	2,758,058
	naphtha	anhydrous copper sulfate	Pure Oil Co.	2,755,227
	naphthas	copper chromite & copper molybdate	Pure Oil Co.	2,755,226
Distillation	liquids	fluidized solids system	Esso Research & Engineering Co.	2,758,073
Elutriation	solids fines	continuous withdrawal	Houdry Process Corp.	2,754,966
Forming	composite body	metal & powdered refractories	M. W. Kellogg Co.	2,755,199
Heat Exchange	hydrocarbon streams	independent, parallel cracking units	Houdry Process Corp.	2,755,232
Hydration	olefins	catalyst of tungsten & titanium oxides	Imperial Chemical Industries, Ltd.	2,755,309
Hydrocracking	hvy. hydrocarbons	moving bed catalyst	Socony Mobil Oil Co., Inc.	2,758,067
Hydrogenation	benzene	catalyst in plurality of contact zones	Universal Oil Products Co.	2,755,317
	unsat. & oxy. cmpds	HF & fluid Pt-alumina cat.	Esso Research & Engineering Co.	2,757,128
Hydrotreating	lube oils	platinum on alumina catalyst	Esso Research & Engineering Co.	2,756,183
Increasing	selectivity	steam treatment of fluid cracking cat.	Esso Research & Engineering Co.	2,755,231
Improvement	cat. cracked naphtha	fractionation & P_2O_5 treatment	Esso Research & Engineering Co.	2,756,181
	lube oil viscosity	polyhalogenated C_1-C_2 hydrocarbon	Esso Research & Engineering Co.	2,755,224
Manufacture	acids	aldehydes, alcohols and Fe catalyst	Stanolind Oil & Gas Company	2,756,248
	aldehydes	olefins, CO, H_2 & cobalt catalyst	Esso Research & Engineering Co.	2,757,202
	aldehyde & alcohol	olefins, CO, H_2 reaction & separation	Esso Research & Engineering Co.	2,757,203
	alkyl aryl sulfonates	H_2SO_4-alkyl benzene reaction	California Research Corp.	2,757,195
	alkylated polystyrene	polystyrene, nitrobenzene & olefin	Esso Research & Engineering Co.	2,756,265
	asphalt	petroleum residue & hydrogen halide	Shell Development Co.	2,755,223
	benzene hexachloride	CCl_4 and actinic light	Lande, Knorr & Aeugle	2,758,077-8
	boehmite alumina	aluminum-water reaction	Universal Oil Products Co.	2,758,011
	butylxylene	HF, BF_3, xylene & butylbenzenes	Standard Oil Co. (Ind.)	2,756,264
	catalyst	cobalt, molybdenum & alumina	Houdry Process Corp.	2,755,257
	catalyst	sintering of metal & alkali metal oxides	Sprague Electric Co.	2,755,236
	dairy wax	paraffin, microcry. wax & polyethylene	Esso Research & Engineering Co.	2,758,100
	dehydrogenation cat.	oxides of Al plus Cr, Mo, W, U, and/or V	Phillips Petroleum Co.	2,755,323
	grease	carbon tetrachloride & lube oil	Esso Research & Engineering Co.	2,755,249
	grease	oil & alkali metal soap & hydroxide	The Texas Co.	2,755,247-256
	cyclohexanone oxime	cyclohexanone & hydroxylamine sulfate	Phillips Petroleum Co.	2,756,258
	odorless min. spirit	acid treat, water, wash, & alkali treat	Standard Oil Co. (Ind.)	2,756,184-5
	heat insulation	aq. alkaline earth metal silicate	Columbia-Southern Chemical Corp.	2,754,547
	higher aromatics	naphthene-olefin catalytic reaction	Phillips Petroleum Co.	2,755,318
	high MW nitriles	ammoniation of carboxy acids	Sinclair Refining Co.	2,755,301
	lube oil additive	catalyzed lube oil oxidation	Phillips Petroleum Co.	2,758,069
	paper coating wax	recovery of narrow wax cut	Esso Research & Engineering Co.	2,756,180
	2-phenylpentane	HF, BF_3, C_6H_6 & bis(3-pentyl-) benzene	Standard Oil Co. (Ind.)	2,756,263
	polymethyl benzenes	pseudocumene conversion	Shell Development Co.	2,756,261
	unsat'd, organic cmpds.	pyrolysis of allylic halide	Shell Development Co.	2,755,322
Oxidation	CH_4 to CHO	O_2, CH_4 & nitrogen oxides	Gutehoffnungshutte Oberhausen AG	2,757,201
	reactants	superpressure from adsorption on catalyst	Union Oil Co. of Calif.	2,756,127
	waste stack gases	platinum catalyst	Standard Oil Co. (Ohio)	2,756,121
Polymerization	ethylene	bis-diazobenzene succinate	The Borden Co.	2,758,107
	olefins	continuous system	Esso Research & Engineering Co.	2,755,324
	olefins	inorganic & organic phosphorus compounds	Esso Research & Engineering Co.	2,758,143
Prevention	H_2S corrosion	NH_4 in tank vapor space	Esso Research & Engineering Co.	2,757,056

(Continued on p. 130)

If you're not in the book *you're a man without*

. . . . . a country
. . . . . a state
. . . . . a county
. . . . . a town
. . . . . a party
. . . . . a street
. . . . . a school
. . . . . a *vote*

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Get your name in the book
—and do it now!

Is your name in the book?

Patents

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
Purification	C_2Cl_6	amine and distillation	Ethyl Corp.	2,755,235
	melamine in vapor	cooling & crystallization	American Cyanamid Co.	2,755,887
	naphthenic acids	two-zone distillation	Esso Research & Engineering Co.	2,758,071
Reaction	adsorbed materials	granular catalytic adsorbent	Union Oil Co. of Calif.	2,756,247
Recovery	heat	fluidized solids system	Sinclair Refining Co.	2,755,782
	o-xylene from isomers	crystallization, & filtration & dist.	Esso Research & Engineering Co.	2,757,215
	p-xylene from isomers	crystallization & filtration	Esso Research & Engineering Co.	2,757,216
Refining	lube oils	act. bentonite or silica gel adsorbent	Shell Development Co.	2,756,196-7
Regeneration	aromatizing catalyst	CO_2-containing flue gas	Universal Oil Products Co.	2,758,098
	caustic alkali soln.	$CuSO_4$ cat. & oxygen to remove RSH	British Petroleum Co. Ltd.	2,757,074
	fluid adsorbent carbon	low & high temp. desorption	Esso Research & Engineering Co.	2,758,099
	fluidized catalyst	oxygen-flue gas combustion	M. W. Kellogg Co.	2,758,068
	fluid reformer cat.	temperature control	Esso Research & Engineering Co.	2,756,216
	Ni poisoned crack. cat.	phosphorus pentoxide & steam	Socony Mobil Oil Co., Inc.	2,758,097
Removal	Va & Na in hvy. dists.	bauxite catalyst & hydrogen	British Petroleum Co. Ltd.	2,758,060
Separation	acetylene in gas	volatile solvent	Koppers Co., Inc.	2,754,930
	aromatics in paraffins	sulfur dioxide extraction	Phillips Petroleum Co.	2,758,141
	carbonyl-s in gases	aq. alkali metal hydroxide	Esso Research & Engineering Co.	2,758,005
	Co from Oxo aldehydes	oxalic acid or acid or CO	Esso Research & Engineering Co.	2,757,200, 4-6, 377
	Co carbonyl in ald.	water-carbonyl reaction	Esso Research & Engineering Co.	2,757,079
	dialkyl sulfates	sulfuric acid and isoparaffin	California Research Corp.	2,758,142
	diolefins in mixtures	conjugated diolefin addition prod.	Phillips Petroleum Co.	2,756,267
	C_2H_4O in gases	aq. absorption & stripping	Shell Development Co.	2,756,241
	heterocyclic N cmpd.	dist. with S., giving polymerizable mat'l	Phillips Petroleum Co.	2,757,130
	H_2S from hydrofined liq.	inert stripping gas	British Petroleum Co. Ltd.	2,757,127
	NH_3 from HCN product	countercurrent H_2O scrubbing	Deutsche Gold- and Silber-Scheideanstalt	2,756,841
	nitrogen bases	water-CO_2 solution extraction	Phillips Petroleum Co.	2,755,282
	olefins in mixtures	extraction & distillation	Socony Mobil Oil Co., Inc.	2,756,266
	organic sulfides in H_2O	sodium chloride	Pure Oil Co.	2,755,305
	pumpable acid sludge	alcohol from acid treated lube oil	Esso Research & Engineering Co.	2,755,233
	sulfonic acids in petrol.	selective organic solvent	Phillips Petroleum Co.	2,757,194
Stabilization	visbroken residues	virgin fuel oil	Gulf Research & Development Co.	2,755,229
Stripping	catalyst	fluidized catalyst reactions	Standard Oil Co. (Ind.)	2,758,066
Sulfonation	turpentine	anhyd. H_2SO_4, separ. & neut.	A. E. Zoppa	2,757,193
Superheating	saline water	direct gas contact heating zone	Freeport Sulfur Co.	2,756,029
Synthesis	gasoline	hydrocarbon, cat., H_2 & solid carbon	Phillips Petroleum Co.	2,756,194
Treatment	green petrol. coke	O_2-containing gas to stop agglutination	Godfrey L. Cabot, Inc.	2,755,234
Vaporization	hydrocarbons	high temp. & no coking	Rütgerswerke AG	2,758,061
Withdrawal	solid reforming catalyst	without loss of reaction gases	Socony Mobil Oil Co., Inc.	2,756,193

PRODUCTS

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
Adduct	hydroxyl & carboxyl aromatic	hexamethyl phosphoryl amide	Union Oil Co. of Calif.	2,756,252
Composition	phenoxyalkyl	dithocarbamate group	Esso Research & Engineering Co.	2,756,249
Grease	lube base oil	poly (siloxyglycol) thickener	California Research Corp.	2,756,212
	lube oil	amate-dicarboxylate thickener	California Research Corp.	2,756,213
	neutral lube oil	fatty acid, hydrated lime, NaOH & phenol extract	Pure Oil Co.	2,755,248
Lubricant	ester	branched & straight chain alkyl groups	Esso Research & Engineering Co.	2,757,139
	C_2H_4O & C_3H_6O	fatty acid & alkylene glycol	Shell Development Co.	2,755,250
	lube oil	detergent amino compound	California Research Corp.	2,758,086
	lube oil	"extreme pressure" additive	Shell Development Co.	2,758,091
	lube oil	oxidation inhibitor	Socony Mobil Oil Co., Inc.	2,758,087
	reaction of H_2O_2	Mo or Va & P-S-hydrocarbon	Standard Oil Co. (Ind.)	2,758,089
Penetrating Oil	mineral oil base	penetrating additive	Esso Research & Engineering Co.	2,758,088
Reforming Catalyst	chromia	alumina & silica & molybdena	Socony Mobil Oil Co., Inc.	2,757,145
Wax	hydrocarbon wax	styrene-butadiene copolymer	Esso Research & Engineering Co.	2,756,217
	petroleum wax	solid diaryl ketone inhibitor	Marathon Corp.	2,755,193

EQUIPMENT

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
Contact	gases & liquids	tray having step-wise baffles	Koch Engineering Co., Inc.	2,757,915
Control	liquids	plug valve	Socony Mobil Oil Co., Inc.	2,757,895
Exchange	heat	upright pebble exchanger	Phillips Petroleum Co.	2,756,130
	heat	vertical shell & header structure	Westinghouse Electric Corp.	2,756,028
Generation	vapors	waste heat boiler	Babcock & Wilcox Co.	2,754,807
Heating	gases	pebble heater	Phillips Petroleum Co.	2,756,030
Relief	pressure	spring loaded valve	Phillips Petroleum Co.	2,754,841
Separation	undersize pebbles	screening in pebble heater	Phillips Petroleum Co.	2,755,174
	vapors & solids	countercurrent cascade stripper	Esso Research & Engineering Co.	2,756,514
Storage	gases	pressure controlled system	Gulf Oil Corp.	2,757,067
Sweating	paraffin	heat exchange box	Ruhrchemie AG	2,758,057

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- **Boiler Feed Water Supplies.**
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 (To obtain more data on advertised products see page 142)

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First Details of ASME Annual

THE ANNUAL meeting of the American Society of Mechanical Engineers will, in its choice of topics, offer a virtual cross-section of industry. There will be sessions on metals engineering, hydraulics, applied mechanics, heat transfer, instruments and regulators, and a host of other topics. The meeting will be at New York's Statler and McAlpin Hotels, Nov. 25-30.

The refinery or design engineer will find papers of interest to him in several of the sessions. Following is a selection of papers from the tentative program:

Hydraulics

"Pressure Drop for Parallel Flow Through Rod Bundles," by B. W. Le Tourneau, R. E. Grimble, and J. E. Zerbe, Westinghouse Electric Corp.

"Losses in Pipe and Fittings," by R. J. S. Pigott, Consulting Engineer.

Effect of Temperature on Metal Properties

"Basis for Design and Retirement of Petroleum Heater Tubes," by J. J. Heller, Union Oil Co. of California.

"Experiences with Chromium-Molybdenum-Vanadium Material for High-Temperatures Bolting Applications," by R. G. Matters and C. D. Dickinson, Allis-Chalmers Mfg. Co.

Petroleum

"Application of Gas-Liquid Cyclones in Oil Refining," by J. R. J. van Dongen, N.V. Bataafsche Petroleum Mij.

"Concurrent Flow of Water, Oil and Air in a Horizontal Pipe," by Donald P. Sobocinski, University of Kansas, and R. L. Huntington, University of Oklahoma.

Instruments & Regulators

"Method for Presenting the Response of Temperature Measuring Systems," by Robert Looney, Taylor Instrument Cos.

"Responses of Temperature Sensing Element Analogs," by G. A. Coon.

Management

"First Line Supervision—How Do They Spend Their Time: Case Studies and a Program for Improvement," by Jerome Underhill, Merck & Co.

"Engineering as a Function of Management," by John A. Ritchey, Purdue University.

"The Engineer Studies Administration," by Keith C. Harder, Navy Dept.

Fuels

"Competition, Substitution, and Demands Among Fuels," by Paul McGann, U.S. Bureau of Mines.

"Prospects of Future Fuel Costs," by Perry Teitlebaum, National Planning Assn.

Heat Transfer

"Convection Heat Transfer and Pressure Drop of Gases Flowing Across In-Line Tube Banks":

"Part I—Apparatus, Procedures and Special Effects," by C. E. Jones, Babcock & Wilcox Co., and E. S. Monroe, Du Pont Co.

"Part II—Correlation of Data for Ten-Row Deep Tube Banks," by A. J. Gram, Babcock & Wilcox Co., C. E. Mackey, Cornell University, and E. S. Monroe.

"Shell-Side Characteristics of Shell and Tube Heat Exchangers," by Townsend Tinker, Ross Heat Exchanger Div. of American Standard Co.

"Heat Transfer and Fluid Friction During Flow Across Banks of Tubes," by Ole P. Bergelin and M. D. Leighton, University of Delaware, and Kenneth J. Bell, Case Institute of Technology.

Applied Mechanics

"Head Loss in Flow Through a Cyclone Dust Separator or Vortex Chamber," by Helmut E. Weber, Shell Development Co., and Joseph H. Keenan, M.I.T.

A special fuels luncheon on Nov. 27 will have as speaker Clyde Williams, president of Battelle Memorial Institute. His topic will be "The 'New Look' for Fuels and Power."

At the heat transfer luncheon on the same day Peter Courvoisier, of the observatory at Davos, Switzerland, will discuss "The Utilization of Solar Energy."

Meeting to Tell Uses for Radioactivity in Refining

Applying radioactivity in research and refinery operations will be the subject of a symposium sponsored by Tracerlab, Inc., at the Hotel Statler, Boston, Oct. 24 to 26.

A day will be spent on orientation talks for people contemplating the

Oil Man's Calendar

(Bold-face items reviewed in this issue)

OCTOBER

1-5 American Institute of Electric Engineers, fall general meeting, Morrison Hotel, Chicago

8-10 Lubrication Conference, sponsored by ASLE and ASME, Chalfonte-Haddon Hall, Atlantic City

11-12 California Natural Gasoline Assn., fall meeting, Sheraton Huntington Hotel, Pasadena

14-20 Oil Progress Week

15-17 National Assn. of Corrosion Engineers, northeast region, Philadelphia

16-17 American Gas Assn., annual, Atlantic City

18 American Institute of Chemical Engineers, New York Section, Hotel Statler, New York

18-19 Western Petroleum Refiners Assn., regional technical-industrial relations meeting, Rufus Garrett Hotel, El Dorado, Ark.

22-24 Rocky Mountain Oil & Gas Assn., annual, Cosmopolitan Hotel, Denver

22-24 National Lubricating Grease Institute, annual, Edgewater Beach Hotel, Chicago

23 Assn. of Consulting Chemists and Chemical Engineers, annual, Belmont Plaza, New York

23-26 National Assn. of Corrosion Engineers, south central region, San Antonio, Texas

24-26 Symposium on Radioactivity in Refining and Research, Tracerlab Inc., Statler, Boston

25-26 National Society of Professional Engineers, fall meeting, Greenbrier, White Sulphur Springs, W. Va.

26 American Institute of Chemical Engineers, S. Texas Section, Galveston, Texas

26 Natural Gasoline Assn. of America, regional, Capt. Shreve and Washington Youree Hotels, Shreveport

NOVEMBER

1-2 Society of Automotive Engineers, diesel engine meeting, Drake Hotel, Chicago

8-9 Society of Automotive Engineers, fuels and lubricants meeting, Mayo Hotel, Tulsa

8-9 National Assn. of Corrosion Engineers, southeast regional, Charlotte, N.C.

12-15 American Petroleum Institute, annual, Conrad Hilton and Palmer House, Chicago

15-16 National Assn. of Corrosion Engineers, north central region, Detroit

25-30 American Society of Mechanical Engineers, annual, Statler and McAlpin Hotels, New York

26-30 3rd International Automation Exposition, Coliseum, New York

27-30 9th National Chemical Exposition, Chicago Section, American Chemical Society, Cleveland

30 Natural Gasoline Assn. of America, Panhandle-Plains regional meeting, Herring Hotel, Amarillo

DECEMBER

3 Synthetic Organic Chemical Manufacturers Assn., annual, Biltmore, New York

6-8 South-wide Chemical Conference, sections of the American Chemical Society, Memphis

9-12 American Institute of Chemical Engineers, annual, Statler, Boston

JANUARY

21-25 American Institute of Electrical Engineers, winter general meeting, New York

28-30 8th Plant Maintenance and Engineering Conference, Statler, Cleveland

FEBRUARY

22 Natural Gasoline Assn. of America, Permian Basin regional, Scharbauer Hotel, Midland, Texas

MARCH

25-27 Western Petroleum Refiners Assn., annual, San Antonio

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use of radioactivity in these industries. The second and third days will be given over to persons from industry talking about technical applications.

Here is a selection of papers to be presented on the final two days:

"Determination of Trace Elements in Petroleum and Catalysts by Neutron Activation Analysis," by George W. Leddicote, Oak Ridge National Lab.

"Radiation Chemical Processing," by Joseph J. Martin, University of Michigan.

"Radiotracers in Refinery Technical Service," by Donald E. Hull, California Research Corp.

"Radioactive Tracer Studies of Catalyst Behavior in Full-Scale Fluid Catalytic Cracking Units," by Vincent P. Guinn and H. Richard Lukens, Jr., Shell Development Co.

"A Study of Entrainment and Leakage in Slat Tray Towers by Means of Radioactive Tracers," by Bruce D. Gibbs, Charles E. Dryden, Charles E. Lapple, Ohio State U.

"Measurement of Fluid Catalyst Densities by Gamma-Ray Absorption," by Richard N. Bartholomew, Shell Oil Co.

"The Cesium-137—Barium-137 Gamma Milker and Its Use in Measurement of Fluidized Solid or Liquid Flow Rates," by Jerome Kohl, Tracerlab.

Chicago AIChE to Hold First Symposium, Nov. 7

The first symposium of the American Institute of Chemical Engineers' Chicago Section will offer two subjects at its Nov. 7 meeting in the Conrad Hilton Hotel. They are "Pros and Cons of Unionism for Engineers" and "What Management Expects of the Engineer."

The symposium will be followed by cocktails and dinner, the latter to offer an "important" speaker.

AIChE Group to Discuss Oil in the Jet Age

The jet age's impact on the petroleum industry will be one of the topics studied at the all-day symposium of the New York Section, American Institute of Chemical Engineers. The meeting will be at the Hotel Statler on Oct. 18.

Chairman of the symposium will be Norman L. Dickinson, manager, refinery plans division, the M. W. Kellogg Co. Speakers and their topics are as follows:

"Oils for the Modern Jet Engine," by W. W. Gleason, Esso Research and Engineering Co.

"Fuels for Gas Turbines and Jet Engines," by G. W. Ferguson, The Texas Co.

"Fuel for the Motor Car of the Jet Age," by P. F. Martinuzzi, Stevens Institute of Technology.

"Gas Turbine Fuels of the Future," by C. F. Hollaway, British Petroleum Co.

A symposium on cost estimation will be a second all-day symposium at the New York Section meeting. A feature will be a round-table discussion, permitting the audience to query speakers on their prepared talks as well as on other subjects in the field.

Five of the six speakers have been selected. They are: Kurt Schaeffer, Merck, Inc.; John Happel, Prof. of Chemical Engineering, New York University; Wallace Taylor, American Cyanamid Co.; Nick Crane, White, Weld & Co.; and Byron Marquis, Singmaster & Breyer. Chairman will be E. Roy Sweet, Singmaster & Breyer.

Refiners on Program of SAE Fuels & Lubes Meeting

Petroleum refiners are hidden behind titles of all but three papers to be read at the fuels and lubricants meeting of the Society of Automotive Engineers. The event is to be held in the Mayo Hotel, Tulsa, on Nov. 8 and 9.

Here are the papers that have special interest to the refining industry:

"Starting and Warm-up Characteristics of New Automobiles," by H. A. Toulmin, Ethyl Corp., G. T. Moore and R. D. Young, Standard Oil Co. (Ind.).

"A Study of the Cold-Starting and Warm-up Characteristics of Some Recent Model Cars," by W. P. Dugan, Sun Oil Co.

"Weather or Lock?", by D. P. Barnard V, R. B. Fell, H. H. Dedo, E. H. Scott, Standard Oil Co. (Ohio), and Gilbert Way, Ethyl Corp.

"Some Factors Affecting Engine Oil Consumption," by H. V. Lowther, Socony Mobil Oil Co.

"Effect of Oil Volatility and Additives on Engine Octane Requirement," by F. S. Wood and C. C. Colyer, Standard Oil Co. (Ind.).

"A Basis for Understanding Antiknock Action," by E. B. Rifkin and Cleveland Walcutt, Jr., Ethyl Corp.

"The Octane Requirement of Passenger Cars at High Altitudes," by P. L. Haines and A. E. Brenneman, Esso Research & Engineering Co.

"Some Factors Involved in Surface Ignition in Spark Ignition Engines," by D. B. Wimmer, Phillips Petroleum Co.

The annual dinner will be held on Nov. 8 and will feature as guest speaker Chester A. Lauck, Continental Oil Co., who is also known as "Lum" of the radio team of "Lum and Abner."

To Find Your Friends

at the American Petroleum Institute's annual meeting in November, use the Directory that will be set up in the lobby of Chicago's Conrad Hilton Hotel. McGraw-Hill's petroleum publications will operate the Directory for your convenience during the meeting.

Girdler building $5,000,000 addition for B. F. Goodrich Chemical Company

A GREATLY INCREASED flow of Geon polyvinyl chloride resins and other plastic compounds will soon be coming from B. F. Goodrich Chemical Company's plant at Avon Lake, Ohio. Girdler—who engineered and constructed existing facilities—will act as general contractor for the expanded processing plant.

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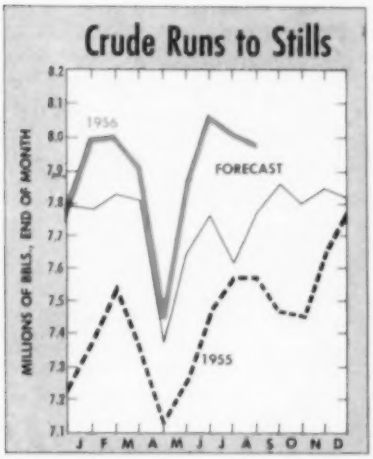
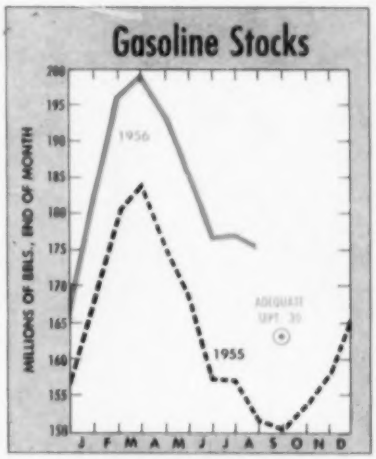
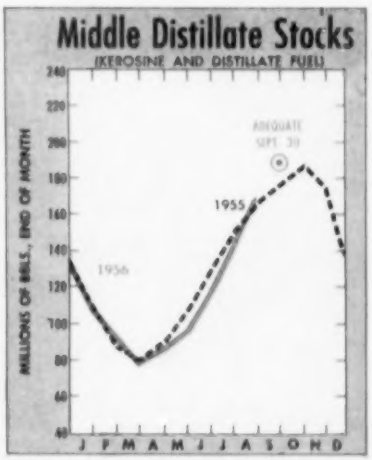





Middle Distillate Stocks
(KEROSINE AND DISTILLATE FUEL)
MILLIONS OF BBLS., END OF MONTH
ADEQUATE SEPT. 30
1955
1956
J F M A M J J A S O N D

Reappraise Stocks in Suez Crisis

OUTLOOK: Largest relative gain in heating oils consumption this winter will be in distillate fuels, particularly No. 2 grade.

ANY interruption in oil shipments through the Suez Canal, in the dispute over control of this waterway, will psychologically and perhaps materially affect the status of refinery operations and product inventories in the U.S.

Demand at refineries here for material to ship to England and the Continent, to replace that formerly coming through the canal, will be principally for heavy and distillate fuel oils. In fact, by the middle of September, some inquiries were being made here for material for export. These products are now in good supply-demand balance in this country, in preparation for needs of the coming winter.

U. S. stocks of heavy fuel oils are about the same as a year ago. (See table p. 139.) East of California they are some larger but the average is mainly in the inland refining districts, less accessible to export than the East and Gulf Coast districts. Domestic demand for heavy fuels will not be much larger than a year ago and refinery output has been moderately increased. However, we are still dependent on imports of this product from the Caribbean to meet our own needs. These sources will also be called upon for any additional shipments to Europe.

Distillate fuel oil inventories east of California, Aug. 31, were about 4% larger than a year ago, and the surplus is in the East and Gulf Coast districts. The domestic market for distillate oils is growing, and total demand at U. S. refineries for the early winter is forecast at 6% larger than a year ago.

U.S. gasoline inventories east of California, Aug. 31, over 154,000,000 bbl. were about 15% larger than a year ago, and they are not being reduced this summer at as large a rate as last year. The increase in these stocks, coupled with smaller gains in inventories of other products by fall, may create a problem for some refiners in finding the required storage facilities, particularly, as now seems indicated, crude runs at U. S. refineries are generally increased because of the Suez crisis.

AUGUST KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbl at end of month)

	Aug. 1956	July 1956	Aug. 1955
CRUDE OIL			
U. S. Production	7.106	7.089	6.665
Imports	.951	1.067	.755
U. S. Stocks	278.461	277.898	256.427
Runs to Stills	7.994	8.011	7.580
GASOLINE			
Refinery Output	3.947	4.000	3.773
Refinery Demand	4.099	4.119	4.034
Primary Stocks	175.571	177.344	151.912
MIDDLE DISTILLATES			
Refinery Output	2.143	2.114	1.911
Refinery Demand	1.346	1.279	1.377
Primary Stocks	170.850	146.147	168.987
RESIDUALS			
Refinery Output	1.122	1.106	1.090
Imports and Other	.387	.352	.367
Total Supply	1.509	1.458	1.457
Refinery Demand	1.419	1.233	1.439
Primary Stocks	46.783	43.958	45.480

PRODUCT AND CRUDE PRICES

(Products—¢ gal, weighted average prices in principal refinery markets
Crudes—$/bbl, principal fields
Source—Platt's Oilgram Price Service)

	Aug. 1956	July 1956	Aug. 1955
Gasoline (regular)	12.04	12.13	11.56
Distillate Fuel Oil	9.28	9.33	8.91
Kerosine	10.89	10.92	10.40
Residuals	5.26	5.26	4.79
Above 4 Products	9.53	9.59	9.06
Lube Oils	22.85	22.69	17.44
Crude	2.84	2.84	2.82

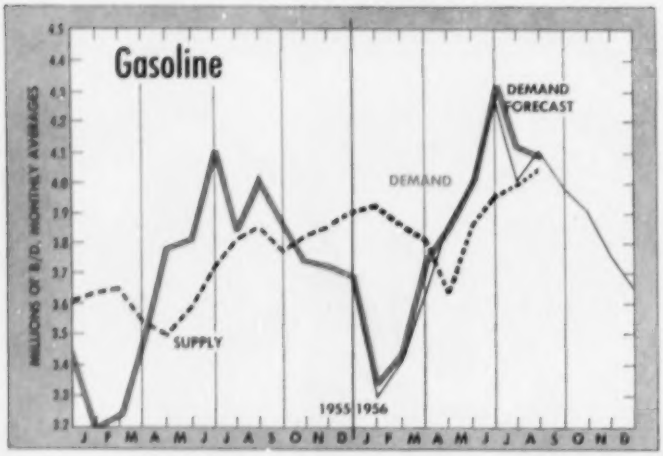
REFINERY YIELDS

% on Crude Runs to Stills

	Aug. 1956	July 1956	Aug. 1955
Gasoline	45.0	44.3	44.8
Kerosine	3.9	3.8	3.8
Distillate	22.9	22.6	21.2
Residuals	14.0	13.8	14.2

SOURCE OF DATA (except prices): July and Aug., API weekly reports; earlier months, Bureau of Mines

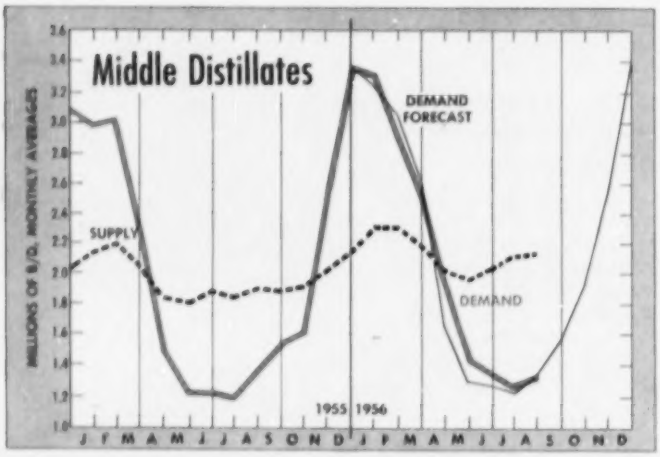
Gasoline Shipments Hold at High Level



MOTOR FUEL

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
Aug. '56	3.594	.448	4.042
Aug. '55	3.129	.429	3.858
Change	+ .105	+.019	+ .184
% Change	+ 4.8	+ 4.4	+ 4.8
DEMAND (including Exports) (Millions of b/d)			
Aug. '56			4.099
Aug. '55			4.034
Change			+ .065
% Change			+ 1.6
TOTAL SUPPLY (Millions of bbl)			
8 Mos. '56	843.195	106.565	949.760
8 Mos. '55	790.043	101.681	891.724
Change	+ 53.152	+ 4.884	+ 58.036
% Change	+ 6.7	+ 4.8	+ 6.5
TOTAL DEMAND (including Exports) (Millions of bbl)			
8 Mos. '56			946.262
8 Mos. '55			897.956
Change			+ 48.306
% Change			+ 5.4

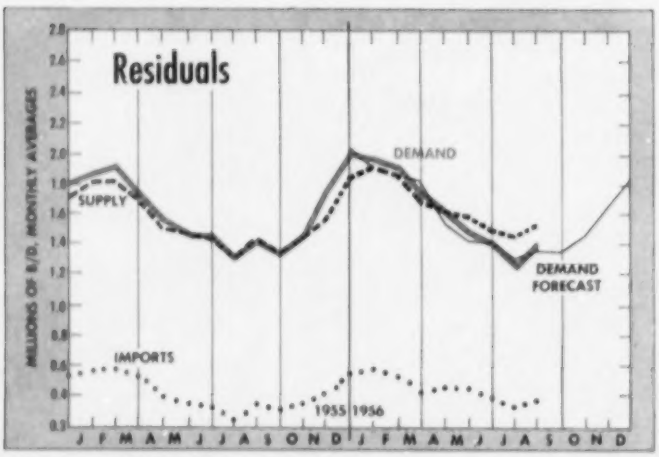
Distillate Demand on the Upgrade


Middle Distillates
DEMAND FORECAST
SUPPLY
DEMAND
1955 1956
MILLIONS OF B/D, MONTHLY AVERAGES
J F M A M J J A S O N D J F M A M J J A S O N D

MIDDLE DISTILLATES

	Kerosine	Dist. Fuel Oil	Total
PRODUCTION (Millions of b/d)			
Aug. '56	.312	1.831	2.143
Aug. '55	.290	1.621	1.911
Change	+ .022	+ .210	+ .232
% Change	+ 7.6	+ 13.0	+ 12.1
DEMAND (including Exports) (Millions of b/d)			
Aug. '56	.212	1.134	1.346
Aug. '55	.207	1.170	1.377
Change	+ .005	— .036	— .031
% Change	+ 2.4	— 3.1	— 2.3
TOTAL PRODUCTION (Millions of bbl)			
8 Mos. '56	79.440	439.941	519.391
8 Mos. '55	78.689	399.459	478.148
Change	+ .751	+ 40.482	+ 41.233
% Change	+ 1.0	+ 10.1	+ 8.6
TOTAL DEMAND (including Exports) (Millions of bbl)			
8 Mos. '56	74.629	417.170	491.799
8 Mos. '55	71.223	377.481	448.704
Change	+ 3.406	+ 39.699	+ 43.095
% Change	+ 4.8	+ 10.5	+ 9.6

Residual Demand At About 1955 Level


Residuals
DEMAND
SUPPLY
DEMAND FORECAST
IMPORTS
1955 1956
MILLIONS OF B/D, MONTHLY AVERAGES
J F M A M J J A S O N D J F M A M J J A S O N D

RESIDUAL FUELS

	Refinery Output	Imports & Other	Total
SUPPLY (Millions of b/d)			
Aug. '56	1.122	.387	1.509
Aug. '55	1.090	.367	1.457
Change	+ .032	+ .020	+ .052
% Change	+ 3.0	+ 5.5	+ 3.6
DEMAND (including Exports) (Millions of b/d)			
Aug. '56			1.419
Aug. '55			1.439
Change			— .020
% Change			— 1.4
TOTAL SUPPLY (Millions of bbl)			
8 Mos. '56	288.086	112.401	400.487
8 Mos. '55	277.704	104.946	382.350
Change	+ 10.682	+ 7.455	+ 18.137
% Change	+ 3.9	+ 7.1	+ 4.7
TOTAL DEMAND (including exports) (Millions of bbl)			
8 Mos. '56			392.390
8 Mos. '55			388.975
Change			+ 3.415
% Change			+ 0.9

SOURCE OF DATA: July and Aug., API weekly reports; earlier months, Bureau of Mines (1956 figures for 366 days)

RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U. S. REFINERY DISTRICTS

(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

RUNS TO STILLS
(Millions of b/d average for week ending on date shown)

District	Aug. 31 1956	Sept. 2 1955	Change	% Change
East Coast	1.141	1.079	+ .062	+ 5.7
Gulf Coast	2.631	2.582	+ .049	+ 1.9
Total Coastal	3.772	3.661	+ .111	+ 3.0
Appalachian	.217	.193	+ .024	+12.4
Ind.-Ill.-Ky.	1.505	1.326	+ .179	+13.5
Okla.-Kan.-Mo.	.741	.691	+ .050	+ 7.2
Other Inland	.699	.655	+ .044	+ 6.7
Total Inland	3.162	2.865	+ .297	+10.4
Total East of Calif.	6.934	6.526	+ .401	+ 6.3
Calif.	1.164	1.116	+ .048	+ 4.3
Total U. S.	8.098	7.642	+ .456	+ 6.0

GASOLINE STOCKS
(Millions of bbl on date shown)

Aug. 31 1956	Sept. 2 1955	Change	% Change
42.706	34.499	+ 8.207	+23.8
33.581	30.429	+ 3.152	+10.4
76.287	64.928	+11.359	+17.5
7.434	6.548	+ .886	+13.5
34.722	32.082	+ 2.640	+ 8.2
18.032	14.920	+ 3.112	+20.9
17.840	15.256	+ 2.584	+16.9
78.028	68.806	+ 9.222	+13.4
154.315	133.734	+20.581	+15.4
21.256	19.558	+ 1.698	+ 8.7
175.571	153.292	+22.279	+14.5

RESIDUAL STOCKS
(Millions of bbl on date shown)

Aug. 31 1956	Sept. 2 1955	Change	% Change
12.458	11.921	+ .537	+ 4.5
8.040	8.929	— .889	—10.0
20.498	20.850	— .352	— 1.7
1.081	.937	+ .144	+15.4
5.459	4.852	+ .607	+12.5
1.660	1.209	+ .451	+37.3
2.783	2.359	+ .424	+18.0
10.983	9.357	+ 1.626	+17.4
31.481	30.207	+ 1.274	+ 4.2
15.302	16.380	— 1.078	— 6.6
46.783	46.587	+ .196	+ 0.4

DISTILATE FUEL OIL STOCKS
(Millions of bbl on date shown)

District	Aug. 31 1956	Sept. 2 1955	Change	% Change
East Coast	49.693	47.392	+ 2.301	+ 4.8
Gulf Coast	23.098	20.731	+ 2.367	+11.4
Total Coastal	72.791	68.123	+ 4.668	+ 6.9
Appalachian	4.010	3.923	+ .087	+ 2.2
Ind.-Ill.-Ky.	24.060	26.249	— 2.189	— 8.3
Okla.-Kans.-Mo.	17.353	14.626	+ 2.727	+18.6
Other Inland	7.330	7.633	— .303	— 4.0
Total Inland	52.753	52.431	+ .322	+ 0.6
Total East of Calif.	125 544	120.554	+ 4.990	+ 4.1
Calif.	12.905	12.811	+ .094	+ 0.7
Total U. S.	138.449	133.365	+ 5.084	+ 3.8

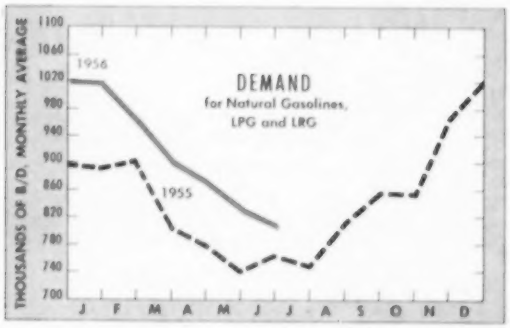
KEROSINE STOCKS
(Millions of bbl on date shown)

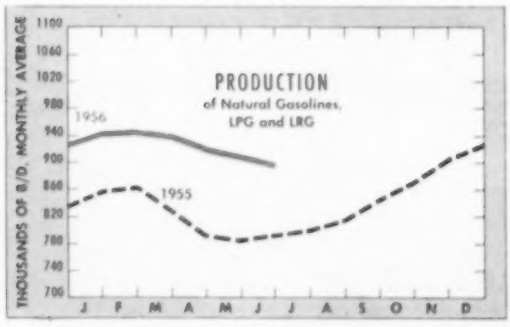
Aug. 31 1956	Sept. 2 1955	Change	% Change
12.050	13.717	— 1.667	—12.2
6.426	6.133	+ .293	+ 4.8
18.476	19.850	— 1.374	— 7.0
1.400	1.268	+ .132	+10.4
7.848	9.225	— 1.377	—14.9
2.819	2.387	+ .432	+18.1
1.536	1.901	— .365	—19.2
13.603	14.781	— 1.178	— 8.0
32.079	34.631	— 2.552	— 7.4
.322	.314	+ .009	+ 2.5
32.401	34.945	— 2.544	— 7.3

TOTAL MIDDLE DISTILLATE STOCKS
(Millions of bbl on date shown)

Aug. 31 1956	Sept. 2 1955	Change	% Change
61.743	61.109	+ .634	+ 1.0
29.524	26.864	+ 2.660	+ 9.9
91.267	87.973	+ 3.294	+ 3.7
5.410	5.191	+ .219	+ 4.2
31.908	35.474	— 3.566	—10.1
20.172	17.013	+ 3.159	+18.6
8.866	9.534	— .668	— 7.0
66.356	67.212	— .856	— 1.3
157.623	155.185	+ 2.438	+ 1.6
13.227	13.125	+ .102	+ 0.8
170.850	168.310	+ 2.540	+ 1.5

Natural Gas and Refinery Gas Liquids





SUPPLY AND DEMAND STATISTICS
(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d monthly average)	June 1956	May 1956	June 1955
At Natural Gasoline & Cycling Plants			
Liquefied Petroleum Gas	375	380	313
Natural Gasoline and Isopentane	302	297	278
Condensate	24	24	20
Finished Gasoline, Naphtha & other	58	58	61
Total Natural Gasoline and Cycling Plant Production	759	759	672
Liquefied Refinery Gases	134	143	123
Total Marketable Gas Liquids	893	902	795
Lease Condensate	117	125	103
Total Natural Gas Liquids	1,010	1,027	898

CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	427	449	387
Natural Gasoline, Isopentane & Other	379	380	378
Total Marketable Gas Liquids	806	829	765

CUMULATIVE PRODUCTION (1000 bbl)	June 1956	June 1955
LPG and LRG	99,865	83,986
Natural Gasoline, Isopentane and Other	68,330	64,635
Total Marketable Gas Liquids	168,195	148,621

CUMULATIVE DEMAND (1000 bbl)		
LPG and LRG	95,779	81,638
Natural Gasoline, Insopentane and Other	67,327	65,051
Total Marketable Gas Liquids	163,106	146,689

STOCKS (1000 bbl, end of month)	June 1956	May 1956	June 1955
LPG and LRG	11,823	9,387	10,105
Natural Gasoline, Isopentane & Other	5,488	5,339	4,242

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Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

CATALYSTS, many types and forms, booklet; Harshaw Chemical Co. See adv't. p. 114.

CATALYSTS, varied forms, booklet: Davison Chemical Co. See adv't. p. 39.

CATALYSTS, for specific applications, information; Atlantic Refining Co. See adv't. p. 117.

CHROMATOGRAPH, with heated sampling valve, bulletin CEC 1831-X5; Consolidated Electrodynamics Corp. See adv't. p. 170.

CLEANING COMPOUNDS, for tanks and process equipment, booklet; Oakite Products, Inc. See adv't. p. 17.

CLEANING EQUIPMENT, hydraulic jet, bulletin 424; Sellers Injector Corp. See adv't. p. 131.

CORROSIN INHIBITOR, prevents and removes scale, technical bulletin; United Chemical Corp. of New Mexico. See adv't. p. 156.

DRYING AGENTS, dessicants, information; Minerals & Chemicals Corp. See adv't. p. 157.

EXPANSION JOINTS, bulletin EJ-1914; Yarnall-Waring Co. See adv't. p. 173.

FILTERS, fluid, literature; Commercial Filters Corp. See adv't. p. 26.

FILTERS, for water, information; Anthracite Equipment Corp. See adv't. p. 131.

FLOW INDICATION, pressure differential transmitter, bulletin 98274; Taylor Instrument Cos. See adv't. pp. 44-45.

FLOW INDICATOR, high pressure, bulletin 360; Brooks Rotameter Co. See adv't. p. 131.

GAGES, tank, automatic, bulletin CP-3007; The Vapor Recovery Systems Co. See adv't. p. 150.

MATERIALS HANDLING, truck, side loading, bulletin 1360; Baker-Raulang Co. See adv't. p. 163

METERING, proportioning and blending equipment, catalogs; Bowser, Inc. See adv't. p. 162

MIST ELIMINATORS, bulletin ME-6; Metal Textile Corp. See adv't. p. 141.

MIXERS, side and top entering, 8 catalogs available; Mixing Equipment Co. See adv't. p. 50.

MIXING, by jet eductors, catalog J-1; Schutte & Koerting Co. See adv't. p. 118.

MOTOR STARTERS, 2200-5000 volts, booklet 1062; E. C. & M. Div., Square D Co. See adv't. p. 154.

OXYGEN ANALYZER, data file 20J-106; A. O. Beckmam, Inc. See adv't. p. 160.

PACKINGS, metallic, file DMPP; Durametallic Corp. See adv't. p. 162.

PUMPS, for metering, booklet; Hills-McCanna Co. See adv't. p. 155.

REFRACTORY, hydraulic setting, brochure RC-28A; Johns-Manville Corp. See adv't. p. 174.

SOLVENTS, for polymers and copolymers, technical information and samples; General Aniline & Film Corp. See adv't. p. 112.

STEAM TRAPS, bulletin 10-55; W. H. Nicholson & Co. See adv't. p. 136.

TEMPERATURE RECORDERS, and indicators, catalog; Electric Auto-Lite Co. See adv't. p. 172.

TEMPERATURE INDICATOR, potentiometer, portable, bulletins 64-I and EDS-23-I; Thermo Electric Co. See adv't. p. 166.

TUBE MAINTENANCE, equipment, tools, bulletin 59; Airetool Mfg. Co. See adv't. p. 121.

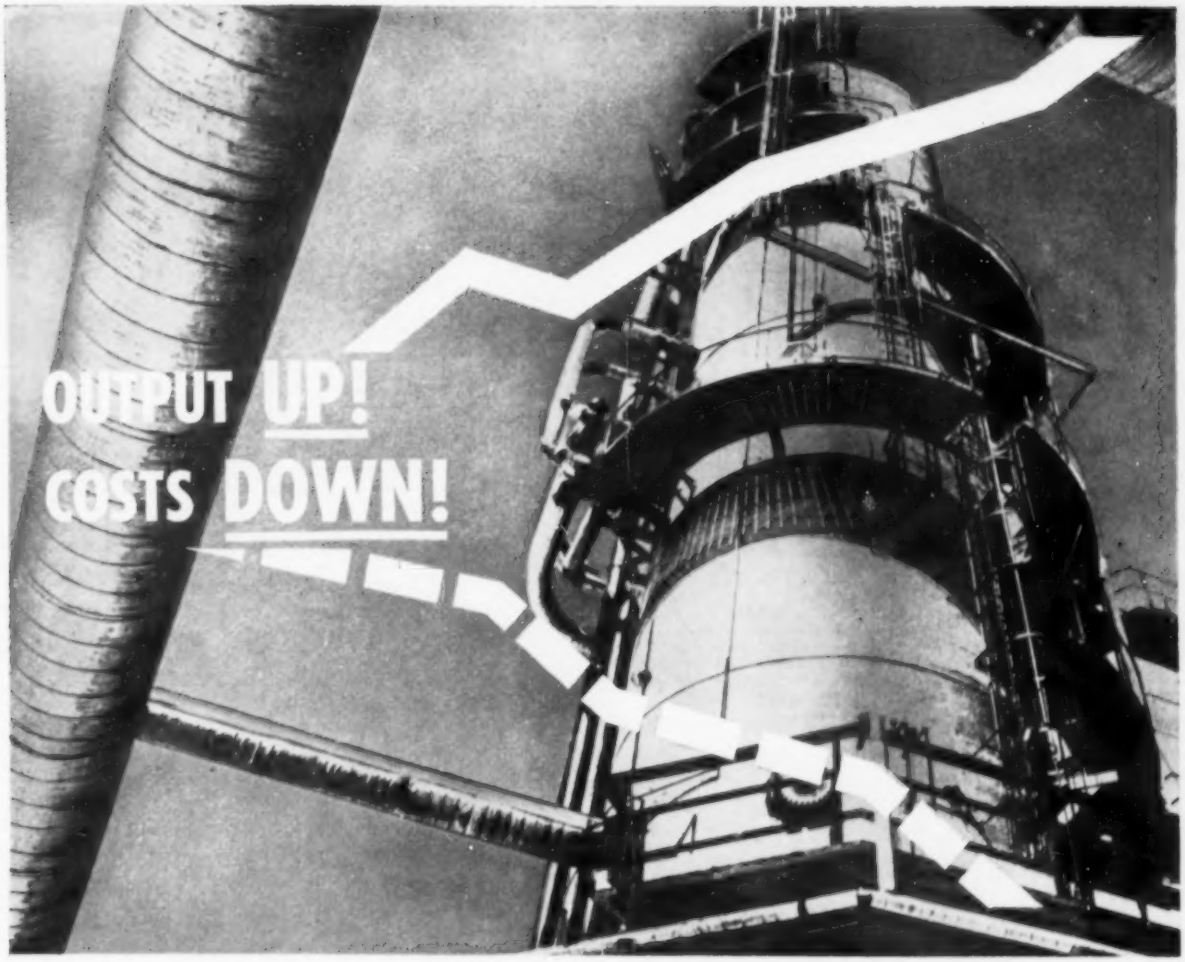
TUBES AND PLATES, alloys, publication B-2; Anaconda Co. See Adv't. p. 42.

UNIONS, forged steel, catalog 56; Catawissa Valve & Fittings Co. See adv't. p. 108.

VALVES, gate, globe and angle, catalog supplement 1; Henry Vogt Machine Co. See adv't. p. 43.

VALVES, lubricated plug, catalog: William Powell Co. See adv't. p. 159.

WIRE SCREEN, for filters and strainers, corrosion resistant alloys, bulletins 6, 7 and 8; Cleveland Wire Cloth & Mfg. Co. See adv't. p. 134.



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6-201

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 (To obtain more data on advertised products see page 142)

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Replace Conventional Heat Transformer Fins

End welded studs were applied at the rate of 2,000 per 8-hr day by two men in the fabrication of a large cooling coil for Sun Oil Co.'s Toledo, Ohio refinery. They were used in place of the conventional heat transfer fins to save labor and time.

The unthreaded studs, ½-in. in diameter and 1½-in. long, were end welded on 1-inch centers in rows 90 degrees apart around the 4-in. cooling tube. The tubing started with an inner 5-ft. diameter circle and expanded outward in a series of coils to a diameter of 32 ft. Using end welded studs eliminated any drilling, punching and tapping and speeded completion of the cooling coil for the new Houdriflow unit. Coil fabricators were Kaighin and Hughes, Inc. of Toledo. The unthreaded studs were from **Nelson Stud Welding Division**, Gregory Industries, Inc., Lorain, Ohio.

Circle No. **1** *on Reply Card*

Digital Volt-Ohmmeter

. . . can be read from a distance of 30 ft or more, even from side angles.

Featuring simple operating controls, the new Model 352 permits non-technical personnel to make accurate measurements in a short time. Designed for industrial uses, the Digital Volt-Ohmmeter is available in both portable and rack mount models. The portable instrument measures 11-in high, 8¼-in wide and 15⅛-in deep; the rack mounted model measures only 5¼-in high, 19-in wide and 15⅛-in deep.

Accuracy of the new instrument is rated at: ±0.1% dc volts; ±2% of full scale from 30 cps to 3 megacycles for ac voltages greater than 1 volt; ±0.% of value read +1 digit ohms. Switching fixed precision resistors in and out of the circuitry assures long-term accuracy.

Short balance time of 1 sec permits high readout and printing rates. Printer connection and automatic printer controls are available for use with parallel entry data printers. A scanner for use with serial entry data printers and complete printing systems is also available. **Non-Linear Systems Inc.**, Del Mar Airport, Del Mar, Calif.

Circle No. **2** *on Reply Card*

Reducing and Relief Valve

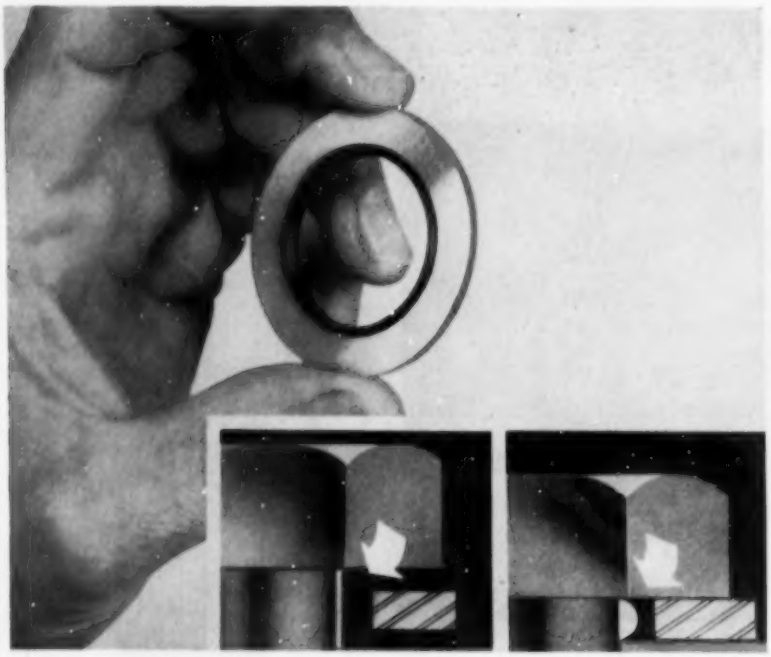
. . . operates on initial pressures to 4,000 psi, and can be adjusted up or down by as little as 2 psi over a wide range of 0-2500 psi.

Designed for low capacity service, the Type "F" valve is spring loaded and diaphragm actuated. The body is of stainless steel bar stock and the trim of bronze and monel. The diaphragm is Teflonfaced neoprene for long service.

The desired reduced pressure is easily adjusted by means of a handwheel located at the top of the valve, with no need for stuffing boxes. This feature permits lowering the reduced pressure against a dead end condition, as for example, testing pressure vessels. When installed directly in a line supplying a low amount of oil, air, or water to a process, it is possible to vary the controlled pressure in increments of two or three psi. **Atlas Valve Co.,** 280 South St., Newark, 5 N.J.

Circle No. **3** *on Reply Card*

Continued on p. 146



Pressure Seal . . .

Is Effective Up To 10,000 PSI

This one-piece pressure seal is adaptable to sealing high pressures effectively under bolt heads, abutment flanges, or similar flanges which require sealing between two faces with the bore open to pressure.

The "Dyna-seal" consists of an inner sealing member made of Hycar American rubber, a special synthetic rubber made by B. F. Goodrich Chemical Co. that has unusual resistance to oil, grease, chemicals and abrasion. This inner rubber ring is heat and pressure bonded to an outer ring or washer. High tensile, cadmium plated cold rolled steel is used in the confirming washer.

The device supplies a positive lock washer action since the resilient sealing lips of the inner ring form a convex surface opposing the steady or pulsating pressure. It is an effective seal up to 10,000 psi against water, air, all types of petroleum products, and many industrial gases. It will function in a temperature service range from —65°F to 250°F. Seals are available in sizes from ⅛ to 1¼-in. **Precision Rubber Products Corp.,** Dayton, Ohio.

Circle No. **4** *on Reply Card*

Valve-Coupling

. . . for use as a hand valve or quick coupler consists of a primary valve within a secondary valve.

The primary valve is first to open and last to close, serving as a safety device for the main valve. As the two members are engaged, O-rings seal the connection prior to the opening of two poppet valves and the main piston valve. In breaking the connection, the main piston valve seals off the line flow and reduces the pressure within the valve. The poppet valves seal the residual fluid in the valve bodies, and each joint is additionally sealed by the O-rings.

All sealing elements and working parts are fully enclosed and protected form outside damage. A J-slot locking design permits rocking the coupling to break frozen joints; thus, it is not necessary to close off the fluid at the header or wait for defrosting of the connections before breaking out a line. The valve-coupling can be mounted stationary or used as a hose-to-hose coupling. **Harbison-Fischer Mfg. Co.,** P. O. Box 127, Fort Worth, Texas.

Circle No. **5** *on Reply Card*

Slide Calculator

. . . provides quick answers to questions of cost and quantity conversions for chemical additives. Aimed primarily at the petroleum industry, the calculator provides answers in gals/bbl as well as ppm.

Specific quantities calculated on the slide calculator include gal/bbl, ppm, lbs/bbl, cost/lb, cents/bbl, and mils/bbl. Additional conversion scales relate API gravity and lbs/gal, and °C to °F. The calculator may be obtained by writing **Armour and Company,** Chemical Division, 1355 W. 31st St., Chicago 9, Ill.

Circle No. **6** *on Reply Card*

Explosion-Proof Lantern

. . . operates in hazardous areas on one or two 6-volt batteries.

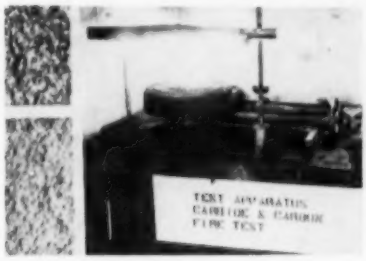
The electric hand lantern has a sparkproof case of drawn brass finished in red enamel. Wires from the batteries to the lantern head are sheathed in flexible brass tubing. Lead seals on the battery and lamp containers prevent tampering.

A special device prevents afterglow of the lamp filament if the bulb is broken. A high pressure spring holds

the bulb in contact with the socket. If the bulb cracks or breaks, the spring crushes the bulb and simultaneously ejects it from the socket.

This hand lantern that throws a 1500 ft beam is approved by Underwriters' Laboratories for Class 1, Group D hazardous locations. **U-C-Lite Manufacturing Co.,** 1050 W. Hubbard St., Chicago 22, Ill.

Circle No. **7** *on Reply Card*



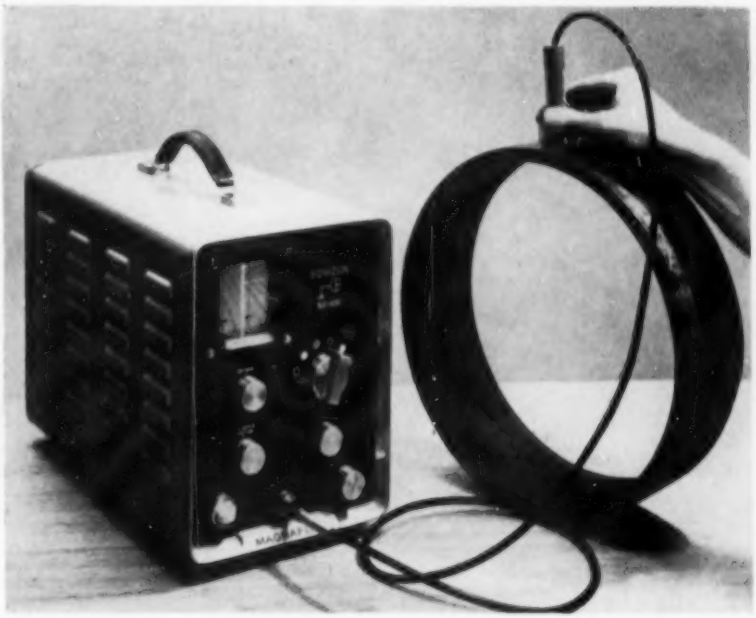
Fire Retardant Coating

. . . insulates against a 2,000°F flame as well as serving as a water and rust-proof coating. It weathers well and will withstand acid and alkali fumes and will not support mildew.

The fire-retardant material, No. 5501, is a heavy-bodied black mastic which can be sprayed or trowelled to a thickness of ¼ to ⅜-in. on metal, wood, fibreboard and other materials. It will not run, drip, drop off or contribute fuel to the flame. Developed as a heat and fire-retardant coating for metal vessels, and for structural supports, the mastic can be used wherever high temperatures are encountered.

In the range of —20° to 250°F, the mastic can serve as an interior or exterior coating for insulation, reducing condensation, preventing rust and waterproofing. Conventional mastic spray equipment can be used for application; coverage is 100 sq ft per 20 gals for a ¼-in thick coating. **Insul-Mastic Corporation of America,** Dept. A-39, 7750 West 61st Place, Summit, Illinois.

Circle No. **8** *on Reply Card*



Small Ultrasonic Instrument . . .

Measure Thicknesses From One Side Only

The SO-100 Sonizon is a portable thickness tester that is designed for production testing, and weighs only 30 lbs. The indicating thickness "pip" is indicated on a TV type tube mounted on the face of the control box. A 5-ft cable connects the control box thicknesses.

Applicable for testing almost all sound conductive materials, the Sonizon is simple to operate. A single crystal probe is touched or slid over the material to be tested. Inaudible sound waves are emitted from the crystal into the test piece through a couplant such as oil, glycerin or soap film. When the constantly varying drive frequency hits the resonance equal to the thickness of the material there is a lead change on the crystal. This is translated into a thickness reading and appears as a "pip" on the scope.

Scales for various thicknesses are stored right in the unit, and the proper scale is selected by turning a knob. Calibration is in thousandths of an inch for the type of material tested. The "pip" indicates the thickness of the material.

Using a simple harmonic calculator which is furnished, the range of the Sonizon is extended to materials up to 4-in. thick. With this instrument it is possible to detect thin spots in walls of cast, formed, welded or ground objects; eccentricity in cast iron pipes; or compare unknown thicknesses of vessels with known thicknesses. Accuracy is to ±2% of thickness, or ±1% when checking against a known thickness. **Magnaflux Corporation,** 7300 W. Lawrence Ave., Chicago 31, Ill.

Circle No. **9** *on Reply Card*

Plastic Lining

. . . is applied hot and employs no solvents. The plastic epoxy coating is chemically resistant to most acids, alkalies, aliphatic, aromatic and hydrocarbon solvents.

The result of three years of research to reduce the application hazards of plastic linings, the "Gusco Plastic Cladding" process uses heat to replace dangerous solvents. Application for large tanks is by a new heated spray gun that internally mixes a liquid epoxy resin and hardener before atomization. Coatings of 100% solids which average 15 mils per coat can be applied to steel, concrete or wood at rates up to 500 sq.ft./hr.

The new spray gun weighs only 1 lb and operates with conventional trigger action. Hot material is supplied to it in proper proportion from a portable heating and pumping machine that weighs 85 lbs. Power requirements are 25 amps at 115 volts ac.

Visual control of the application is possible through a three color system. Since the hardener and resin are each of a different color, and combine to produce a third color, visual observation will tell the efficiency of application. **A Gusmer, Inc.,** Woodbridge, N.J.

Circle No. **10** *on Reply Card*

Continued on p. 148

"Start Pilot" . . .

Provides Quick Starting for Engines

A precision engineered starting device, "Start Pilot" provides quick starting on all gasoline and diesel engines, even at temperatures as low as —60°F. Used successfully in Europe, the device injects a small quantity of ignition-promoting fluid as a fine spray, mixed with air, into the engine intake manifold. This keeps the engine firing until the regular fuel can sustain combustion.

The Start Pilot unit uses a special low ether content blend of starting fluid packed in sealed capsules. Not affected by temperature or humidity, the starting fluid has lubricating qualities that protect the cylinder walls and upper piston area. It also contains a corrosion inhibitor that neutralizes the formation of acids caused by condensed water mixing with sulfurous components of the fuel oil during cold starts.

The Start Pilot unit is available in kit form for installation, and includes the main unit containing the capsule chamber and hand-operated double action air pump; a spray nozzle which is screwed into the engine intake manifold; and copper tubing to connect the pump unit to the spray nozzle. **Wilco Co.,** 4425 Bandini Blvd,. Los Angeles 23, Calif. or **Start Pilot Corp.,** 258 Hericks Road, Mineola, Long Island, N.Y.

Circle No. **11** *on Reply Card*

Electromagnetic Flowmeter

. . . converts liquid velocity directly into an electric potential without any inherent pressure drop. Accuracy is high for liquids possessing electrolytic conductivity.

The Nucor Magnaflow instrument has instantaneous and full-linear response; the dynamic range of the instrument is limited only by the hydraulic system and limits of operating pressure. Rates as low as 100 cc/mm and as high as 2000 gpm can be measured.

The measuring element is a smooth bore, Teflon tube with platinum electrodes, which introduces no additional pressure drop into the line. Two types are available: Type A accommodates flow tube diameters from 3/16 to 1¼-in; Type B accommodates diameters from 1½ to 10-in. Standard units operate up to 1,000 psi; special units to 2,500 psi and higher. Temperatures for instrument operation range from 350°F on the standard units up to 500°F on special units.

The instrument is adapted to the flow of highly corrosive or radio-active liquids, slurries, various suspensions, and other fluids which have conductivity properties. It will not measure pure hydrocarbons. **Nuclear Corporation of America, Inc.,** Empire State Bldg., New York 1, N.Y.

Circle No. **12** *on Reply Card*

Water Analyzer

. . . permits instantaneous measurement of water, down to less than one part per million. The measured output can be sent to any standard recorder.

The instrument operates by passing the wet gas stream at a regulated rate over a hygroscopic substance, which is electrically conductive only when wet. The absorption of all the water in the hygroscopic substance permits quantitative electrolysis, with the water content determined as a function of the electrical current.

The portable instrument weighs less than 50 lbs and may be operated by battery if desired. This "DuPont Model W Electrolytic Water Analyzer" is similar to one described at the Pittsburgh meeting of the American

"M-S ··· M-H"

(MAXIMUM SERVICE - MINIMUM HEADACHE)

from WESTERN HEAT EXCHANGERS

And Here's Why

The accelerated pace of today's business problems, whether they be in engineering, operations, sales or management, makes it more important than ever that the supplier of your process equipment be attuned to *your* specific needs.

Many Operating and Engineering executives in the petro-chemical field, from both large and small companies, have found Western Supply Company to be *their* kind of supplier in design, fabrication and service of Heat Exchangers.

And, we believe, for good reason . . .

WESTERN'S *Specialists*

. . . are highly trained, flexible, young and experienced, having a full appreciation and acceptance of the heat transfer problem . . . using the latest and best data available.

WESTERN'S *Accurate Ratings*

. . . are a result of the technical skill of Western's engineers, the latest data and their knowledge of field-proven installations — assuring that each exchanger is sized to give the most economical unit for the job.

WESTERN'S *Modest Size*

. . . makes Western easy to do business with . . . flexible in thought, ingenious in design, fast-moving in emergencies.

WESTERN'S *Techniques and Tools*

. . . include all of the latest machines and equipment necessary for producing quality equipment, with skilled craftsmen in direct supervision over each step of fabrication.

WESTERN'S *Personal Attention*

. . . to each detail of our customer's specifications and needs can be traced from the initial contact to the finished product, resulting in a close customer relationship thru the years.

Western Heat Exchangers merit your consideration on your existing or future heat transfer requirements. We'll appreciate your inquiry.

WESTERN
HEAT EXCHANGERS

WESTERN SUPPLY COMPANY
P. O. BOX 1888 • TULSA, OKLAHOMA

HUDSON-RUSH COMPANY — 753 Gladstone Blvd., Shreveport, La.
130 Casa Linda Plaza, Dallas, 18, Tex.
P. O. Box 3151, Amarillo, Tex.

PROCESS INSTRUMENTS & EQUIPMENT CO. — North Bldg., Charleston, W. Va.

H. W. SEVERANCE — 2416 Frankfort Ave., Louisville, Ky.

"Varec" AUTOMATIC TANK GAUGES

MAGNETIC DRIVE for HIGH PRESSURE PETROCHEMICAL SERVICE

FIG. NO. 2500C

When you buy automatic tank gauges for petrochemical service – accuracy and safety are important requisites. "Varec" offers you both. Accuracy is assured by counter and dial reading, clear and distinct–without the danger of parallax or difficulty of reading a scummy tape. Dependable safety is insured by the magnetic drive rotating the counter and dial reading mechanism, Remote Gauger Transmitter or other auxiliary equipment. Prevents pressurizing sight glass chamber or transmitter housing. Isolates both from corrosive or dangerous tank vapors. Sight glass is kept clear without use of wiper. No danger to personnel by possible glass breakage.

In addition to these exclusive features, the Fig. No. 2500C and Fig. No. 2500CR have a host of advantages:

1. Neg'ator motor for motive power.
2. S.S. type 316 sheaves.
3. Shielded type 316 ball bearings.
4. All parts either 316 S.S. or pure aluminum – natural electrical ground – no plastics.
5. Gravity compensator for product change.
6. Built to API Standard 2500 for custody transfer.

FIG. NO. 2500RC

"Varec" Fig. No. 2500C is designed for gauging liquid level of chemicals stored in high pressure spherical tanks. Gauge head has heavy carbon steel flange to permit bolting for high pressure service.

"Varec" Fig. No. 2500CR is an inverted design of the Fig. 2500C, permitting its use on all tanks, below or above ground, where top readings are required. Stainless steel tape connects from gauge head to float in a straight line, eliminating use of sheaves and brackets, thus reducing friction and promoting greater accuracy.

Both types are available in two operating pressure ranges: 150# p.s.i.g. and 300# p.s.i.g. These are only two of a wide variety of "Varec" Automatic Tank Gauges. All are designed to be combined with "Varec" Electronic or Pulse Code Telemetering equipment, remote gauging, temperature transmission, automatic tank switching, and remote controls.

Send for "Varec" Bulletin CP-3007 for information on the entire line of gauging equipment.

961.18

THE VAPOR RECOVERY SYSTEMS COMPANY

"Varec"

Compton, California, U. S. A.

Cable Address: Varec Compton Calif., (U.S.A.), All Codes

What's New!

Chemical Society, February of this year. **Manufacturers Engineering & Equipment Corp.,** Hatboro, Penn.

Circle No. **13** *on Reply Card*

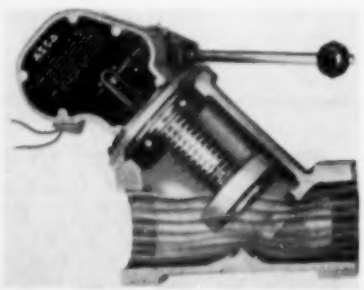
Hi-Temperature Castable

. . . insulates against temperatures up to 3300°F, in furnaces and other hot equipment.

Labeled "Alundum 33-I," this castable insulation is lightweight and monolithic in structure. Aluminum oxide content is about 96%, and it consists of pure alumina bubbles of 6 mesh or finer. Because of its high purity it is suitable for most operating conditions.

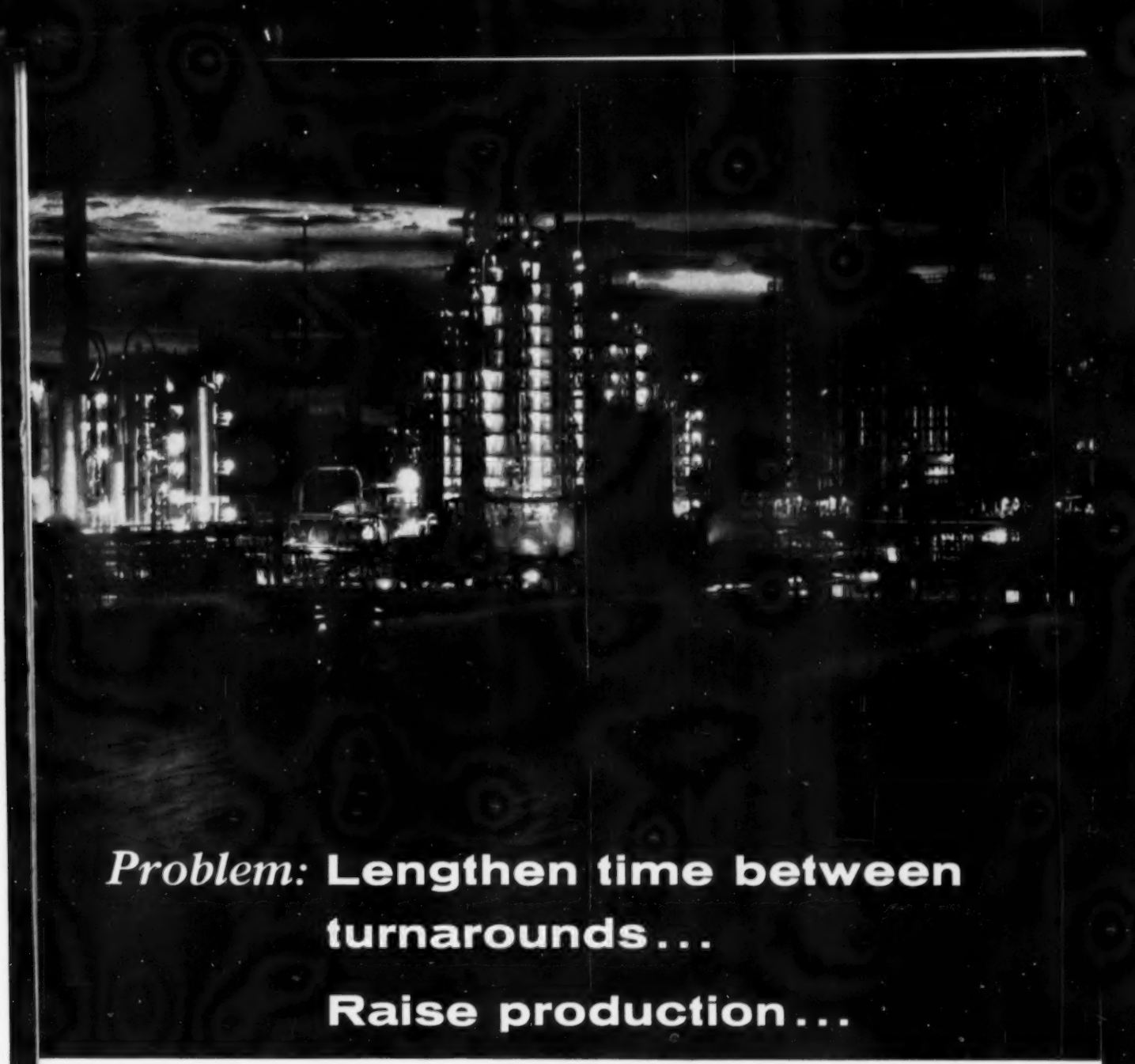
Easy to use, a 100 lb. bag of the castable when mixed and poured forms just one cu. ft. of cast refractory. Final set time is between 18 and 24 hours. **Norton Co.,** Refractories Div., Worcester 6, Mass.

Circle No. **14** *on Reply Card*



Fuel Valve

. . . shuts off automatically upon the failure of power. It is designed for gas supply lines to boilers, furnaces and



Problem: **Lengthen time between turnarounds... Raise production...**

Solution: Ljungstrom® Air Preheater

With a Ljungstrom stills stay on stream at top capacity months longer, because preheated air mixes more thoroughly with fuel. More complete combustion greatly reduces slag forming material. You generate higher flame temperatures, increase heat-transfer rates.

That's why four of your present processing units can do the work of five. With Ljungstrom Air Preheaters each unit's output can increase as much as 25%. Example: One pipe still in an eastern refinery went from 12,000 barrels to 18/20,000 barrels after application of a Ljungstrom.

How fast is "WRITE OFF"?

Ljungstrom has many other advantages. You save up to 20% in fuel... furnace design is more economical, with no need for convection surfaces... many fuels you used to throw away can be used... through-put is consistently improved... product quality is higher. You can see, therefore, why a Ljungstrom is paid out in nine months or less.

For more complete details on what the Ljungstrom Air Preheater can do for you – for an analysis of the heat recovery benefits attainable in fuel burning equipment – call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

PACKAGED TOWER POWER

"Power comes in one piece" on a Marley cooling tower—a completely integrated unit that consists of motor, drive shaft, couplings, Geareducer* and fan hub, assembled and permanently aligned on a rugged unitized steel support.

Every component of this packaged power unit (except the motor of your choice) is Marley-designed and manufactured exclusively and specifically for cooling tower use. Each is engineered for individual mechanical excellence and for functional integration into the complete assembly. All are backed by a single responsibility for dependable performance and economical maintenance, and that backing is the Marley guarantee.

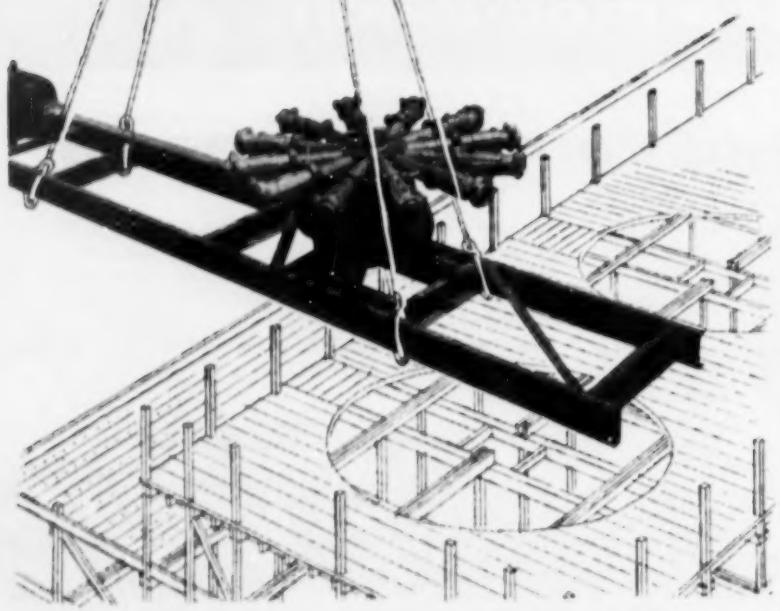
These units are standard for all Marley industrial towers and, together with Marley multi-blade aluminum fans, are available for modernization of towers of any make. Installing the pre-assembled Marley power package for replacement service reduces shutdown time by days.

For detailed information on "packaged power" for new or existing towers, call the Marley sales engineer in any of 55 major cities.

MARLEY **The Marley Company**

Kansas City, Missouri

Founder-Member Cooling Tower Institute

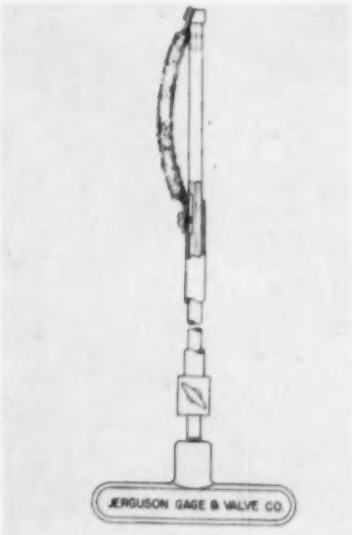


other heating equipment. The same solenoid valve can also be used to handle various grades of fuel oil and non-corrosive liquids and gases.

With a "Y" type body and oversize ports, the safety valve provides flow that is almost equal to that of a straight-through gate valve. Sizes above 3-in are supplied with globe-type body. Double Buna "N" rubber is used for the sliding seal on the valve stem to eliminate leakage, while an integral crown type seat and soft composition disc assure tight shut-off.

Power consumption on the continuous duty class "A" insulated coil is 10.5 watts a.c. or 10 watts d.c. An optional time delay device will prevent the valve from closing on a momentary loss of power. **Automatic Switch Co.,** 391 Lakeside Ave., Orange, N.J.

Circle No. **15** *on Reply Card*



Gage Glass Cleaner

. . . exerts pressure against the inside of the glass tube to remove dirt or stains, unlike the old bottle type brush with bristles.

A cloth swab is slipped over a corrosion resistant spring steel on the end of the rod. Detergent or some other cleaning medium is applied to the swab and the rod inserted into the gage. When the swab is visible in the glass a simple pull back on the handle arcs the spring and forces the swab against the glass. A thumb screw holds the spring taut while the swab is pushed back and forth in the gage glass.

The gage cleaning rods are available in standard lengths of 36-in.;

LOOKING FOR EXTRA OCTANES?

...they've been found with

AEROCAT® CATALYSTS

A survey of 42 cat crackers showed that those using Aerocat were averaging 2½ octanes higher than comparable units operating with natural catalyst! But extra octanes are only one of the benefits assured by Aerocat. High throughput, low stack loss and excellent stability contribute to the high overall efficiency.

Equally important... behind* AEROCAT'S *efficiency stands

OPEN-EYED RESEARCH...that keeps making innovations in catalyst design...keeps looking for new ways to solve catalyst problems.

HARD-HEADED QUALITY CONTROL...that insists on "specification *plus*" in every carload that leaves the plant.

FIELD-TRAINED TECHNICAL SERVICE...that knows how to relate specialized knowledge of catalyst production to your cracking problems.

CYANAMID

AMERICAN CYANAMID COMPANY

REFINERY CHEMICALS DEPARTMENT

30 Rockefeller Plaza, New York 20, New York

In Canada: North American Cyanamid Limited, Toronto and Montreal

 (To obtain more data on advertised products see page 142)

OIL MEN Specify:

2200-5000 Volts

Diesel-Loading pumps with EC&M Div. 2 Starters.

EC&M

50,000 KVA
Interrupting Capacity
MOTOR STARTERS

OUTSTANDING ADVANTAGES

1. Reduced floor space
2. Low-cost Div. 2 design
3. 50,000 KVA interrupting capacity
4. Combination starter with Disconnect Switches
5. Corrosion resistant, weather-proof construction
6. Copper tungsten contacts for positive operation
7. Simple 3-wire TIME-DELAY UVP push button circuit
8. THERMAL-MAGNETIC Overload Relays give accurate motor protection . . . trip instantly on faults
9. All internal wiring complete
10. Self-contained bus and pot-heads are optional

Petroleum engineers specify these Starters for Division 2 semi-hazardous locations because they assure substantial savings in installation and operation.

Construction advantages include: Type III weather-resisting enclosure with drip-proof roof, tank-cover and front-cubicle doors . . . oil switch which opens 220-volt control transformer before upper door can be opened to operate main line disconnects . . . overload and control relays in flanged (Class I, Group D) enclosure with removable cover . . . main contactor with alloy contacts oil-immersed in rear tank. On voltage dips, push button circuit maintained up to 2 seconds by simple 3-wire circuit. "Stop circuit" opens without delay when 'Off button' is pressed.

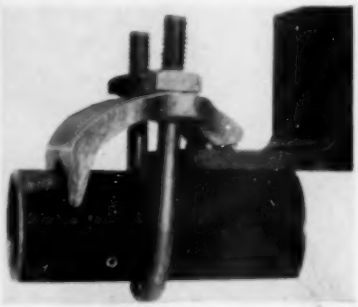
EC&M 2200-5000 volt Starters are also available in Totally Oil-immersed Division 2 Style and in Division I style. Both are available with Oil Disconnect Switch (for main line).

Write for 16-page Booklet 1062 for complete details.

SQUARE D COMPANY
EC&M DIVISION • CLEVELAND 28, OHIO

longer lengths are available on order. **Jerguson Gage & Valve Co.,** 80 Fellsway, Somerville 45, Mass.

Circle No. **16** *on Reply Card*



Pipe Clamp

. . . **permits attachment without drilling** into the attached steel frame. Case hardened tool-steel pieces form a V-shape that gives the clamp a double bite into the piece of steel to which it is attached.

Made of cadmium plated, high quality malleable iron, the clamps are available in two models—one for right angle support (shown above) and the other for parallel support. Each model is obtainable in ten sizes, which handle pipe or conduit from ½ to 4-in. in diameter. **Fullman Manufacturing Co.,** Latrobe, Penn.

Circle No. **17** *on Reply Card*

Heat Exchanger Coil

. . . **contains 540 sq. ft.** of heating surface in 7.2 cu. ft. of space. The unit is designed to heat 3,000 cu. ft. of vapor per minute, using 450 psig steam inside the tubes.

The size of the radiafin coil is only 40¾-in. long by 19¾-in. in diameter. Three banks of hot-dip galvanized steel radiafin coils are mounted within these limits. A rolled steel cylinder separates each bank of coils and provides a baffle and support for the coils. For fabrication, the tubes were first finned and then formed into coils as part of this custom designed heat transfer unit. **Schutte and Koerting**

See how straight reciprocal drive eliminates major replacement part problems.

See how Hills- McCanna metering pumps can meet your exact requirements.

SEE HOW A *new heart* PUTS *new life* IN YOUR WATER TREATMENT SYSTEM!

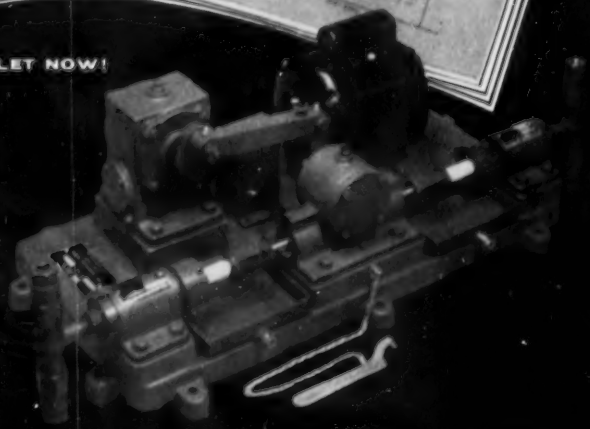
See how Hills- McCanna design gives you greater dependability, accuracy and longer pump life.

HILLS-McCANNA pumps out "new life"

Use any water treatment system

SEND FOR THIS NEW FACT-FILLED BOOKLET NOW!

Here's useful information to help you get more from your present water treatment system . . . to help you in the selection of the proper metering pump for your particular application. This big 12-page booklet is complete with technical information, installation drawings, tables of capacities and pressures, and pump construction recommendations for metering all types of liquids. It's like having a consulting engineer at your fingertips! Write for your copy now!

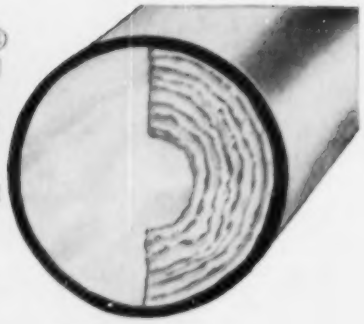


HILLS-McCANNA COMPANY

2448 W. Nelson Street, Chicago 18, Illinois

METERING AND PROPORTIONING PUMPS • DIAPHRAGM VALVES
FORCE FEED LUBRICATORS • MAGNESIUM ALLOY SAND CASTINGS

how
KE-TONE®
prevents and
removes scale



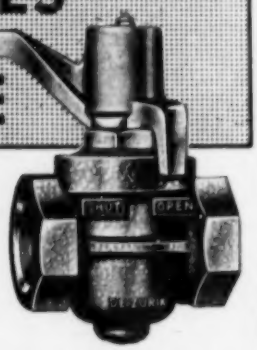
KE-TONE utilizes the best features of the polymerized phosphates and the amino acid chelates to inhibit scale formation and actually dissolve and remove scale deposits. The KE-TONE method of treating the large volumes of water used in cooling towers, boilers and other industrial installations, *loosens, fractures, suspends* and in many instances actually *dissolves* scale. Any suspended or dissolved scale may then be removed in the effluent from the system or in the blow-down. So effective are small concentrations of KE-TONE that large volumes of water may be treated with utmost economy.

Outline your scale problem and send for Technical Bulletin on KE-TONE today.

KE-TONE — "Makes Water Work"

UNITED CHEMICAL CORPORATION
OF NEW MEXICO, HOBBS, NEW MEXICO

DeZURIK VALVES
STOP LEAKAGE



IN SO MANY
PETROLEUM INSTALLATIONS

On bleeder lines from pumping wells, on water treater tanks, on rotary drilling mud, on crude oil tank battery lines, on suction to high pressure oil well cementing pump trucks, on vacuum tanks . . . on these and many other petroleum applications, DeZurik Valves are demonstrating a remarkable ability to stop leakage without constant maintenance. On liquid flow or vacuum . . . you'll find DeZurik Easy-Operating Plug Valves will do a superior job!

Manufactured in a full range of sizes, materials and models
Representatives in all principal cities

DeZURIK SHOWER COMPANY
SARTELL, MINNESOTA

Co., Dept. HT-E, Cornwells Heights, Bucks County, Pa.
Circle No. **18** *on Reply Card*

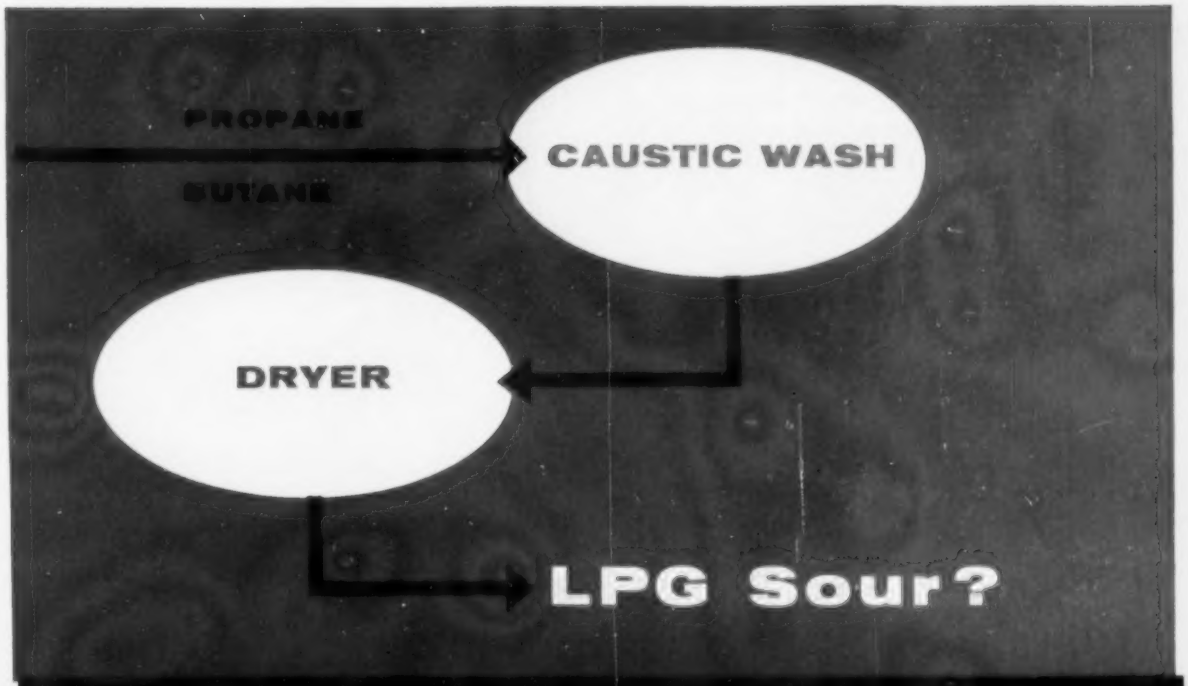
Falling Film Evaporator

. . . **uses carbon wall wipers** to direct the flow downward as well as circumferentially. This sharply reduces the contact time of the distillates and prevents deterioration of heat sensitive materials.

The wipers, made of impervious graphite or other suitable material, are contained in a special retainer which permits free radial motion and easy replacement. Internal machining is eliminated since the short sectioned wipers need no further compensation in radius.

The special wipers are claimed to improve heat transfer, ensure uniform film thickness and prevent fouling, operate more efficiently by lower power consumption, and save space by eliminating the usual external condenser and inter-connected piping. The slow speed at which the still operates eliminates the need for entrainment separators .

This type of construction permits low pressure drops; at an absolute pressure of 1 mm, the pressure drop can be held to less than 0.1 mm. The evaporator is available in a 2-in glass model, and in stainless steel models



Dry it sweet every time with DRIOCEL S®

DRIOCEL S IS NEW. It is a low-cost, activated bauxite desiccant specifically developed to overcome souring of LPG products during the final drying step.

DRIOCEL S PERFORMS A THREE-WAY TASK.

1. It *does* a thorough job of drying the liquefied products.
2. It *does not* exhibit a souring reaction with sulfur compounds which originate in sour gases and crudes —escape the caustic wash—are entrained in the pre-dryer stream (which may deceptively test "sweet")—and then are decomposed in the dryer by ordinary desiccants to yield sour products.
3. Driocel S *does not* act as an acid polymerization catalyst toward heavy ends of the liquefied gases.

LONG SERVICE LIFE—Initial installations put on stream over two years ago are still operating.

THE SPECIFIC PROPERTIES of this new drying agent also suggest its use in the drying of chlorinated and fluorinated hydrocarbons.

Under the well-known brand name of Driocel, M & C offers a *complete* line of reliable desiccants for drying air, hydrogen, CO_2, hydrocarbon liquids and gases—further proof of our ability to solve many a tough processing problem with versatile sorptive minerals. The coupon will put us to work for you.

ATTAPULGUS **POROCEL PRODUCTS** *from*

MINERALS & CHEMICALS CORPORATION OF AMERICA
15 ESSEX TURNPIKE, MENLO PARK, N. J.

ALWAYS A BETTER WAY...

MINERALS & CHEMICALS CORPORATION OF AMERICA
15 Essex Turnpike, Menlo Park, N. J.

Please send me without obligation:

- ☐ Bulletin: "Bauxite As A Drying Agent"
- ☐ Generous sample of Driocel S

name _____ title _____

company _____

address _____

city _____ zone _____ state _____

 (To obtain more data on advertised products see page 142)

NO.2 in a series of ALUMICOAT APPLICATIONS

RESISTS HIGH TEMPERATURE CORROSION!

Alumicoat

Molten Aluminum

PROCESS PROTECTS REFINERY EQUIPMENT

More and more refineries are discovering the advantages of the new ALUMICOAT Process! ALUMICOAT offers a firm resistance against corrosive media — *especially sulphur compounds* — and extreme temperatures!

In the ALUMICOAT Process, refinery parts are dipped in molten aluminum to produce a metallurgical iron-aluminum bond at the interface and a surface overlay of pure aluminum. At temperatures exceeding the melting point of aluminum, the aluminum on the surface diffuses. This diffused coating, together with the iron-aluminum bond, provides a refractory material that gives steel maximum protection against high temperature scaling.

The Alumicoat Process can solve your corrosion and oxidation problems. Send for full details today!

ARTHUR TICKLE ENGINEERING WORKS, INC.

24 Delevan Street MAin 5-4200 Brooklyn, N. Y.

of 12, 24, 36, 48, and 60-inches. The evaporator is also available in monel, hasteloy, nickel and other workable alloys. **Pfaudler Co.,** 1018 West Avenue, Rochester, N.Y.

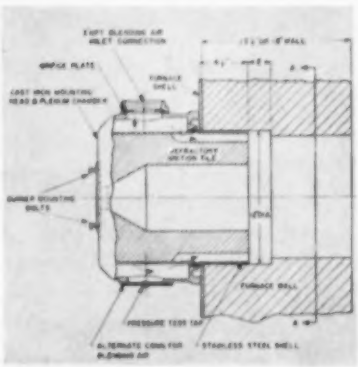
Circle No. **19** *on Reply Card*

Pipe Fitting Template

. . . includes all common fittings and is usable on six different drawing scales.

Condensed on a 5¼ x 8-in. Vinylite template are 91 symbols used in piping drawings. Included is a wide range of commonly used symbols for O.D. pipe, end bells, flanges, and four common fittings. The apertures are available for drawings scaled from ⅛ to ¾-in. scales. The template is priced at $2.50 and includes a protective sheath. **A. Lawrence Karp,** 16 Putnam Park, Greenwich, Conn.

Circle No. **20** *on Reply Card*



Flame Blender

. . . dilutes high temperature combustion products with excess air to ensure complete combustion and better circulation of heat.

Designed for furnaces and heaters with temperatures of 400 to 1800°F. the Hauck Blended Flame Unit is claimed to prevent localized hot spots and provide wider flexibility of operation of heating equipment. This is accomplished by diluting the high temperature combustion products with excess air, which increases their volume while reducing their average tempera-

(To obtain more data on advertised products see page 142)

Powell Lubricated Plug Valves

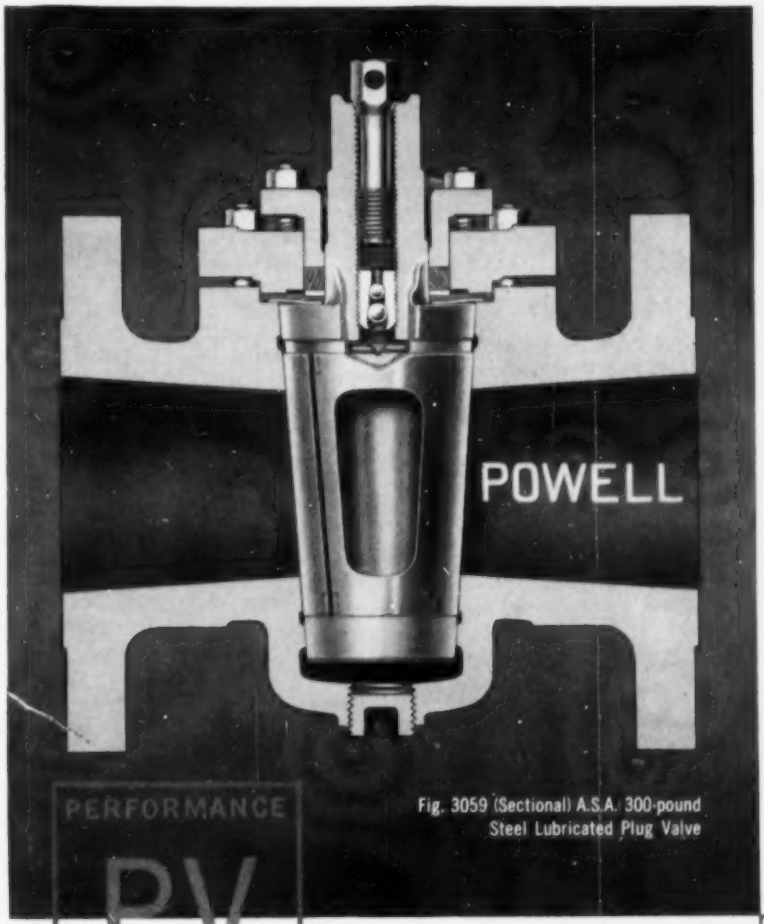


Fig. 3059 (Sectional) A.S.A. 300-pound Steel Lubricated Plug Valve

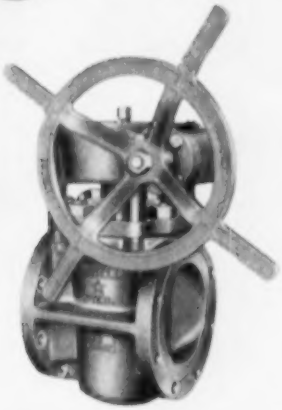


FIG. 1559G—150-pound Steel Lubricated Plug Valve. Gear operated

FIG. 2200—175-pound W.O.G. Semi-Steel Lubricated Plug Valve

Powell Lubricated Plug Valves maintain the 110-year tradition of quality and precision. Only the finest available materials are used. And painstaking quality control is rigidly enforced through each and every step of manufacture.

Valve users who want one source of supply for lubricated plug as well as all types of bronze, iron, steel and corrosion-resistant valves will want full details on Powell Lubricated Plug Valves.

For example, features include quick and positive operation—just a quarter-turn to open or close. Lubricant grooves surrounding each port provide a positive seal when the valve is closed. In an open position, seating surfaces are not exposed. Available in Steel and Semi-Steel through distributors in principal cities.

For full details, write for the new PV-4 Catalog on Powell Lubricated Plug Valves. Just fill out the coupon and mail. Of course there's no charge, no obligation.

THE WM. POWELL COMPANY
2525 Spring Grove Ave.
Cincinnati 22, Ohio

Gentlemen:

Please send me a copy of your PV-4 Catalog on Powell Lubricated Plug Valves. It is understood that there is no cost, no obligation.

*name*_____

*title*_____

*company*_____

*city*_____

*zone*_____ *state*_____

The source of supply for all valve needs!

POWELL VALVES...110th YEAR

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

 (To obtain more data on advertised products see page 142)

OXYGEN

key to modern industrial processes

Control it with...

Arnold O. Beckman INC.

OXYGEN ANALYZERS!

Oxygen is one of the most important factors found in modern chemical and industrial processes. Whether to minimize product oxidation (prepared atmospheres, air infiltration, etc.) ... or to insure adequate oxygen for efficient combustion (boilers, kilns, etc.) ... or to control oxygen for proper process operations (ammonia, acetylene, air fractionation, etc.) oxygen control has become too important in today's operations for any profit-minded executive to overlook.

And because they are the *only* instruments that measure oxygen content directly, accurately and conveniently, Arnold O. Beckman Oxygen Analyzers have become the leading instruments for modern oxygen control in a wide range of applications—from catalytic refineries to cement kilns—from power plants to personnel protection.

These instruments (and systems) can be built to meet *your individual* needs.

These instruments offer many unique advantages...

SELECTIVITY: Highly sensitive to oxygen. Effects of gases other than oxygen are negligible.

HIGH ACCURACY: 1% of full scale (Example: ±0.05% O_2 on range 0-5% O_2).

MANY RANGES: Full scale ranges from 0-1000 ppm or up to 0-100% O_2 available. Combustion ranges 0-5, 0-10, 0-15% O_2 supplied with 0-25% O_2 check range. Multi-range instruments available.

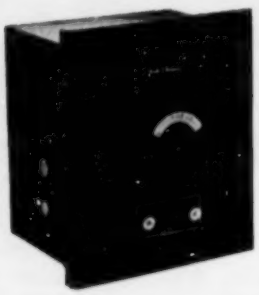
RAPID RESPONSE: Standard Analyzers—95% response in less than 1 minute. Special Units—95% response in 7 seconds!

USE ANY RECORDER: Millivolt output for potentiometers; current output for miniature electronic recorders and galvonometers; air output for pneumatic receivers and control systems.

PACKAGE UNITS: Analyzers and controls may be built into a cubicle with sampling components wired, piped, and ready for installation as a single unit.

SAMPLING SYSTEMS: Complete standard systems—components, package or portable units are available.

OTHER ADVANTAGES: Instruments may be mounted in explosion-proof cases, mounted indoors or outdoors, in portable panels, and have other desired features.



Model F3: Ranges of 0-1%, 0-5%, 0-10%, and higher. Meter on door for convenient readings at sampling point.

Model G2: Full scale ranges 0-0.1%, 0-0.5%, and others for low O_2 content. Ranges 90-100%, 95-100% O_2 for high O_2 content.

The above are but two of the complete line of Arnold O. Beckman Oxygen Analyzers available for every requirement.

Send for helpful free literature which describes Arnold O. Beckman instruments in detail. When writing, outline your particular application—we'll gladly supply specific information.

Data File 203-106

Arnold O. Beckman INC.

ANALYZERS

Profit Builders for Industry

1020 Mission Street

South Pasadena, California

ture. With the expanded volume of gases, circulation and distribution of the heat throughout the heating chamber is obtained.

The unit is designed to create a stable flame and prevent the entry of excess air from interfering with the ignition and combustion of fuel within the refractory tile. Excess air flows outside the tile so that blending occurs only at the tile outlet and periphery of the flame. Thus, combustion goes to completion before complete blending takes place; this is designed to reduce the formation of aldehydes, noxious fumes and smoke-stack haze. **Hauck Manufacturing Co.,** 124-136 Tenth St., Brooklyn 15, N.Y.

Circle No. **21** *on Reply Card*

Free Trade Literature

Compressor Troubles

. . . and their diagnoses: the subject of a *Bulletin PC-509P,* with cartoon sequences of common air-cooled and water-cooled compressor troubles. Common symptoms of each difficulty are listed under the correct trouble heading, such as insufficient pressure, compressor knocking, overloaded motor, and eight other common operating difficulties. Worthington Corp., Merchandising Sales Dept., Harrison, N.J.

Circle No. **22** *on Reply Card*

Control Equipment

. . . for power plants is reviewed in this brochure, *Bulletin 1022-A.* Described in detail are the control systems for combustion and boiler feed water, pressure reducing, desuperheating, and automatic soot blowing. Both rotary and retractable soot blowers are included. Copes-Vulcan Div., Blaw-Knox Co., Erie 4, Penn.

Circle No. **23** *on Reply Card*

Glassed-Steel

. . . or alloy, corrosion resistant process equipment is described in *Bulletin No. 936.* Listed are project engineering facilities for designing new operations or revamping an existing process. The brochure also gives information on custom-built process equipment, glassed steel reactors, alloy reactors, heat exchangers, columns and other processing pieces. Pfaudler Co., 1017 West Ave., Rochester, N.Y.

Circle No. **24** *on Reply Card*

Fatty Acids

. . . tradenamed "Empol 1022" are covered in a 20-page booklet, *Empol*

Believe it or not...

it's integral!

Varying temperatures . . . fluctuating pressures . . . constant vibration. None of these can affect the inherent stability of Wolverine Trufin® — the *one-piece*, finned condenser tube.

The fins of Trufin are squeezed right from the tube wall, are completely integral with the tube itself. That means longer on-stream time — more mileage when the going is tough.

Trufin can step up the capacity of your existing unit, when revamping, or can permit the design of a smaller unit (*with a bigger punch!*) when new heat exchangers are considered. Replace prime surface tube with Trufin Type S/T (low finned) in water-cooled condensers. Specify Trufin Type H/R (high finned) for air-cooled applications. Investigate the Trufin story — NOW! Write for the Trufin Opportunity Book.

Wolverine Trufin is available in a wide range of sizes and types in copper, copper-base alloys, aluminum and electric-welded steel.

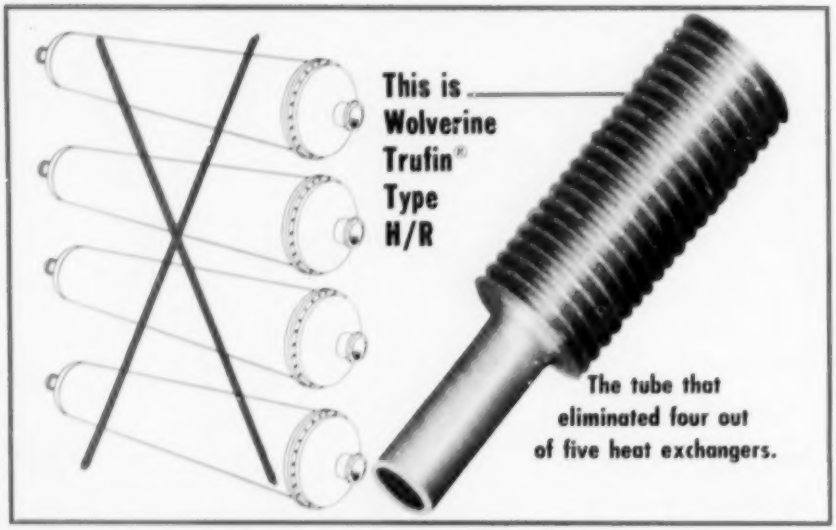
DIVISIONS OF
CALUMET & HECLA, INC.

CALUMET DIVISION
WOLVERINE TUBE DIVISION
CANADA VULCANIZER
& EQUIPMENT CO. LTD.
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER CO.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
1461 CENTRAL AVENUE, DETROIT 9, MICHIGAN
Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES



Here's a Real Success Story:

ONE TRUFIN TUBED HEAT EXCHANGER ELIMINATES FOUR PLAIN TUBE UNITS

By Ernest Dodd

UP NEAR the Canadian border, in a large chemical plant, processing engineers have a real look of respect in their eyes these days as they study the performance record of a certain heat exchanger.

There's every reason why they should because this is an amazing success story—one that would have delighted the heart of Horatio Alger, Jr.

The heat exchanger, which is tubed with Wolverine Trufin Type H/R condenser tube, was designed as the result of an alternate proposal made when management was considering plans for construction of an ethylene superheater.

The plan under consideration called for five plain tube heat exchangers capable of superheating 31,300 pounds per hour of ethylene vapor from minus 100°F to minus 20°F. Total heat duty amounted to 720,000 BTU's per hour.

The alternate proposal rocked management right back on its collective heels. Instead of five heat exchangers using a total of 5,680 *feet of plain tube* this plan called for the same heat duty to be achieved by *one exchanger tubed with only 2,790 feet of Trufin Type H/R condenser tube.*

It didn't take management long to make its decision. After all, one heat exchanger for five is a pretty fair deal in any league—especially when you consider the juicy savings in tube, shells, headers, baffles and labor.

No success story would be complete without a happy ending—and this one has it. After slightly more than one year of operation, the single Trufin-tubed unit has maintained top efficiency—*with a minimum of maintenance.* It has, according to the customer, met management's every expectation.

Integral Fins Give Wolverine Trufin More Surface Area

In the installation described at the left, hot ethylene liquid is used on the tube side to superheat ethylene vapors on the shell side.

For this particular type of operation, a high-finned tube such as Wolverine Trufin Type H/R is particularly effective because its integral fins give maximum heat transfer surface.

Trufin Type H/R is available with five to nine fins per inch in copper and copper-base alloys and with five to eleven fins per inch in lightweight aluminum.

Like the rest of the Trufin family of condenser tubes, Type H/R has integral fins squeezed directly from the tube wall. In addition to increasing surface area, the integral fins can never come loose from vibration, thermal shock or pressure variations.

Wolverine Tube Offers Free Trufin Literature

Wolverine's Trufin Catalog carries complete descriptions of each type of Trufin condenser tube. In addition to sizes, metals and alloys the catalog also describes the various applications where integral-finned tube can be used to full advantage. For your free copy write Wolverine Tube at the following address.

5467

DIVISIONS OF CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO., LTD.
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER CO.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
1441 CENTRAL AVENUE, DETROIT 9, MICHIGAN

Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA.
SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPT., 11 E. 40TH ST., NEW YORK 16, N.Y.

STRUTHERS WELLS

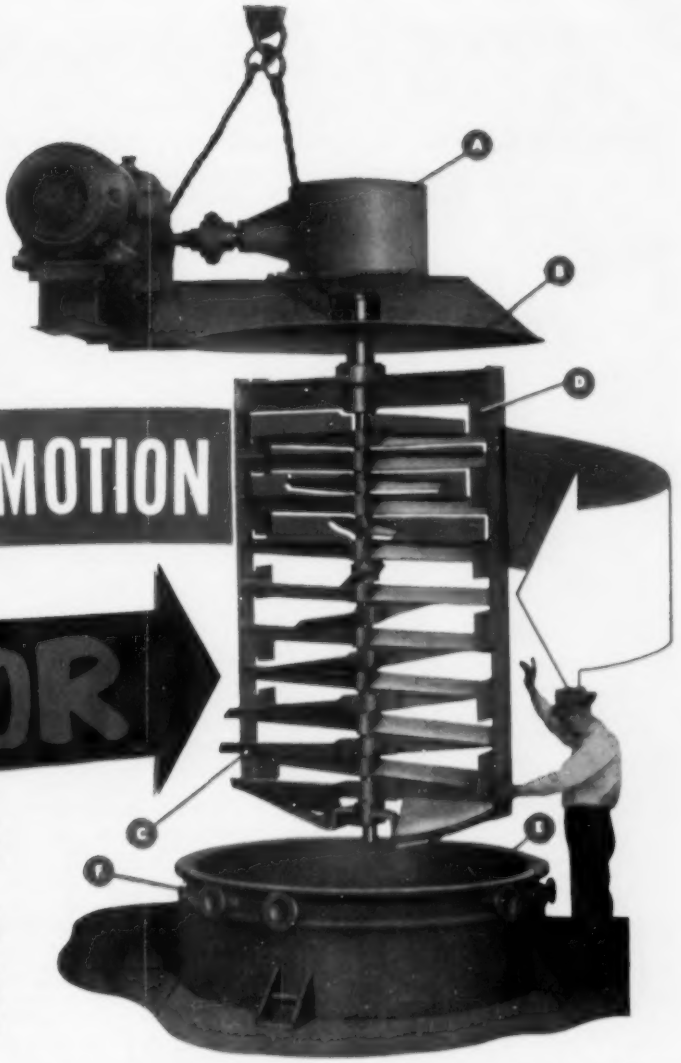
MIXING VESSEL

FOR PROCESSING

HEAVY VISCOUS

MATERIALS

Struthers Wells DOUBLE MOTION AGITATOR



- **A** — **Double motion drivehead, an exclusive Struthers Wells design. Horsepowers from 2 to 150. Furnished with sealing devices when used on pressure kettles.**
- **B** — **Kettles can be open flat top, or dished and flanged closed top for working pressures as high as 300 lbs.**
- **C** — **Sweep and paddle arms are pitched to create flow of material throughout kettle—preventing stratifying of the mix. Scraper frame and paddle arms can be of welded design or bolted for easy removal when vessel is equipped with a cover.**
- **D** — **Scraper blades are advanced hinged type, which insures positive scraping action on 98% of the inside surface of mixer.**
- **E** — **Mixer can be fabricated of steel or special alloy to meet specifications.**
- **F** — **Kettles furnished with jacket or unjacketed for possible direct fire application.**

For speed, economy and dependability—specify the Struthers Wells Double Motion Mixing Vessels—for processing greases and other heavy viscous materials. Our extensive machine shops and fabricating facilities—combined with years of engineering experience in designing all types of agitating vessels, enable us to furnish mixing equipment for any material, to your most rigid specifications.

For intricately designed or standard mixing equipment—*think first of Struthers Wells.*

STRUTHERS WELLS PRODUCTS

PROCESSING EQUIPMENT DIVISION

Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

BOILER DIVISION

BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

FORGE DIVISION

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

MACHINERY DIVISION

MACHINERY for Sheet and Structural Metal Forming . . . Tangent Benders . . . Folding Machines . . . Roller Table and Tumble Die Bending Machines . . . Press Brakes . . . Punching and Notching Machines . . . Forming Dies

STRUTHERS WELLS *Corporation*

Struthers Wells

WARREN, PA.

PLANTS AT WARREN, PA. AND TITUSVILLE, PA.

Offices in Principal Cities

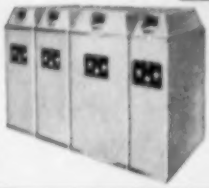
 (To obtain more data on advertised products see page 142)

BOWSER

SYSTEMS SPEED PROCESSING TO CUT PRODUCT COST

METERS · FILTERS

Metering and filtering of liquids from bulk receipts through delivery assure quantity and quality control.



BLENDERS · DEHYDRATORS

Closed system proportioning and blending of liquid stocks plus continuous dewatering where needed, deliver a better end-product at lower cost.

Write for Catalogs

All equipment available on lease or purchase payment program . . .

BOWSER PROGRESSIVE PROCUREMENT PLAN

BOWSER NATIONWIDE SALES AND SERVICE

REGIONAL OFFICES: ATLANTA · BOSTON · CHICAGO · CLEVELAND · DALLAS · KANSAS CITY · LOS ANGELES · NEW YORK

BOWSER, INC., 1329 E. Creighton, Fort Wayne, Ind.

DURAMETALLIC *Packings*

Write today for FILE No. PMPP describing the complete line of Durametallic wear-free packings.

Product of

DURAMETALLIC CORP., KALAMAZOO, MICH.

Also manufacturers of rotary mechanical seals, oil pressure systems and packing tools.

What's New!

1022 Polymerized Fatty Acid. In addition to a complete description, specifications, characteristics and shipping data, the booklet contains application data in many fields. Some of these of interest to the petroleum industry are as adhesives, lubricants, corrosion inhibitors and coatings. A complete end-use bibliography is included for those wishing detailed information. Emery Industries, Dept. 5, Carew Tower, Cincinnati 2, Ohio.

Circle No. **25** *on Reply Card*

Nuclear Technology

. . . and its application to the design of reactors, experimental facilities and their operation. This 10-page booklet describes the research and development facilities which are available from this engineering group formed in 1952 as industrial consultants in the growing field of nuclear technology. Walter Kidde Nuclear Laboratories, Inc., Garden City, Long Island, N.Y.

Circle No. **26** *on Reply Card*

Data System

. . . that links the sensing elements and the computer: the Beckman Model "111" Data System is described in this 16-page brochure, *Bulletin 494*. A pinboard programmer, the Beckman "111" performs three functions—monitoring, recording, and processing data—before it is passed onto the digital computer for analysis of a continuous process. Scientific Instruments Div., Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif.

Circle No. **27** *on Reply Card*

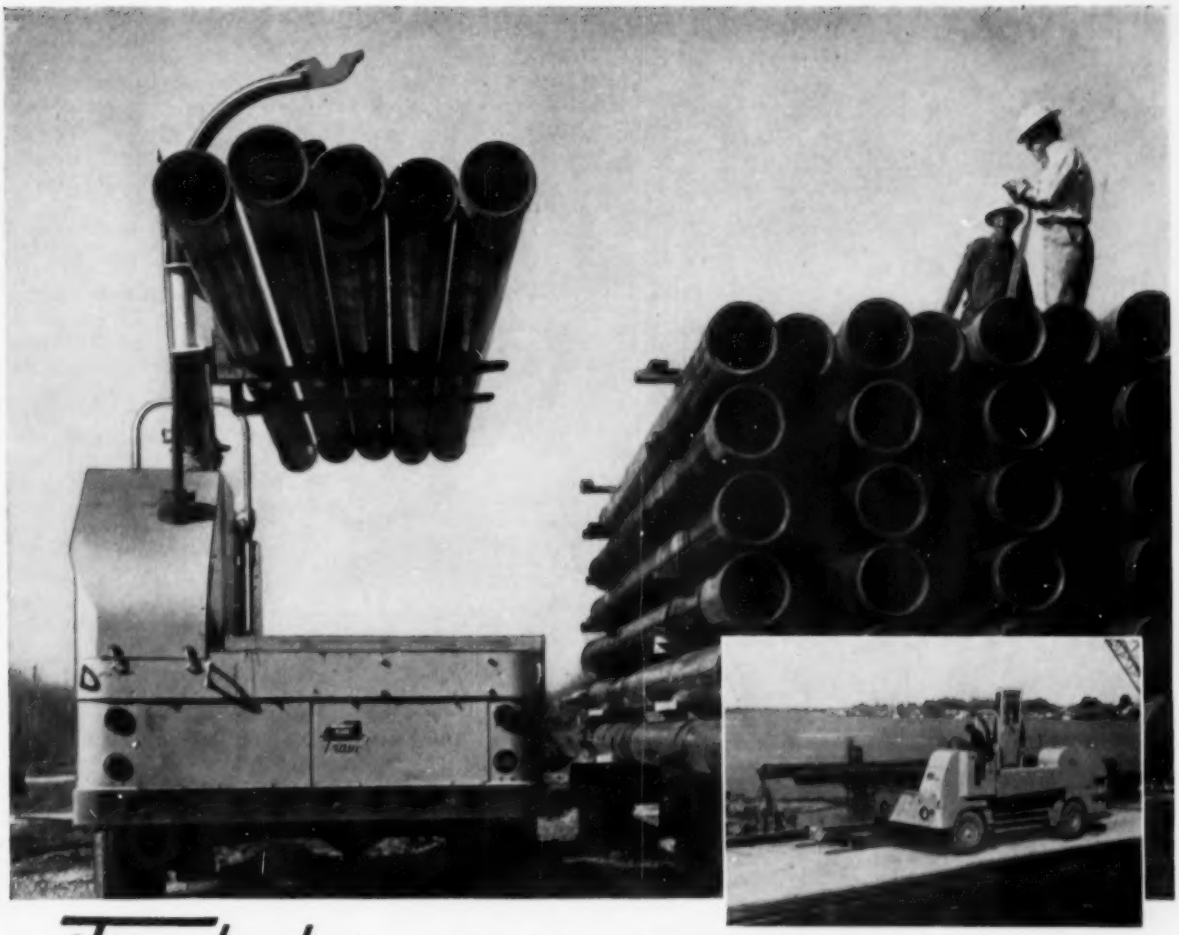
Engineering Drawings

. . . incorporate the latest technology in construction methods for acid resistant brick installations. Graphically diagrammed are details of acid proof masonry construction for six typical installations, a pump base, a column pad, tank outlets, bell and spigot joints, floors and trenches. The drawings are available from Pennsalt Corrosion Products, 3 Penn Center Plaza, Philadelphia 2, Penn.

Circle No. **28** *on Reply Card*

Antioxidant

. . . how it works and its uses: an 8-page pamphlet on *Antioxidant AC-1* describes the oxidation mechanism involved in hydrocarbon systems and how this chemical inhibits it. The properties of this antioxidant and its



®Traveloader replaces 3 trucks and releases 6 men for other work!

● A Traveloader is used by Kyle-Taylor Lumber Company, Berwick, La., to transport pipe from river dock to storage. It has replaced two pipe trailers and a gin-pole truck formerly used on this job, reduced man-power required from 15 to 9 and made time savings of about 70%.

This company, serving oil producers, receives pipe in barges at the river dock. A truck crane unloads and places the pipe on the dock. The Traveloader picks it up five lengths at a time, transports it to the storage yard, and stacks it neatly on racks for further disposition.

Time studies reveal the speed with which Traveloader works. Loading time at dock averages 35 seconds. Hauling to storage, stacking and returning to dock (round trip .55 miles) averages 3 minutes 8 seconds. The stacking part of this operation takes only 24 seconds! As a result the crane at the dock never has to wait for the Traveloader.

Since the company operates 24 hours, 7 days per week, the cost savings are substantial. Moreover, 6 more workers were made available without increasing payroll, and two less mechanized units require maintenance. "This machine is by far the finest that I have seen for handling pipe. It has doubled our capacity with less labor," says Mr. J. E. Kyle, Jr., Vice President.

Write for Bulletin 1360. It completely describes the remarkable TRAVELOADER that carries like a straddle truck, delivers like a road truck, and stacks like a fork truck.

Baker handling equipment

THE BAKER-RAULANG COMPANY

1248 WEST 80th STREET • CLEVELAND 2, OHIO

A Subsidiary of Otis Elevator Company

612

applications in gasolines, oils, rubber, and plastics are briefly touched upon. Catalin Corp. of America, One Park Ave., New York 16, N.Y.

Circle No. **29** *on Reply Card*

Tube Expanders

. . . and related tools are described with detailed specifications in *Catalog No. 88*. Containing 119 pages, the new catalog devotes special sections to the use of each piece of equipment as well as a detailed engineering description. Products included are expanders, general accessories, measuring instruments, rollers, extensions and drives. Thomas C. Wilson, Inc., 21-11 44th Ave., Long Island City 1, N.Y.

Circle No. **30** *on Reply Card*

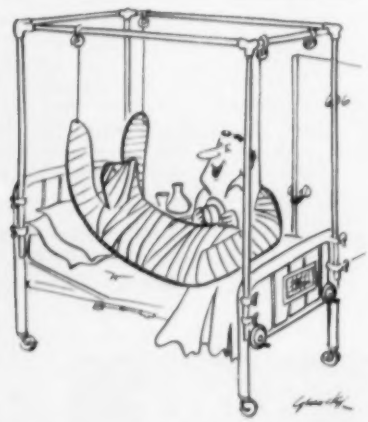
Pipe Hangers

. . . which provide a constant load-supporting capacity for systems subject to expansion and contraction: *Bulletin 156* is a 16-page brochure describing Navco Counterpoise hangers, and gives complete specifications for the entire line of hangers. Engineering drawings of all models, weight-load selection tables, and erection and adjustment information is included. National Valve and Manufacturing Co,. 3100 Liberty Ave., Pittsburgh 1, Penn.

Circle No. **31** *on Reply Card*

Materials Handling

. . . and power transmitting machinery is the subject of Link-Belt Co.'s *Book 2653*. Describing in its 44 pages not only the equipment available but also picturing industrial applications, the brochure includes a bibliography of



"Er . . . Think you can remember that formula? . . . That explosion was a beaut . . ."

Since "way back when," Monsanto has been helping lube manufacturers like you with the chemical problems of petroleum additives.

Modern Example:

IMPROVING GEAR LUBE PERFORMANCE TO MEET THE EXACTING MILITARY AND AUTOMOTIVE SPECIFICATIONS FOR HIGH-TORQUE, HIGH-SPEED OPERATION

What was needed was a true multi-purpose additive that would help heavy-duty gear lubricants stand up under the extreme pressures of high torque without sacrificing high-speed performance. Monsanto chemists developed Santopoid 22 and Santopoid 22 RI.

Gear lubes fortified with either . . . passed both high-speed and high-torque field trials in all automotive equipment tested on desert runs and mountain runs for 3 years . . . in 1954, 1955 and 1956.

Superior High-Torque Performance . . . for the past year Santopoid 22 has protected expensive heavy-duty worm-gear trucks used in grueling mountain hauling.

Excellent High-Speed Protection . . . before adding Santopoid 22, a racing car chewed up rear-end gears every 75-100 miles. Since changing to a Santopoid 22 fortified gear lube, 350 miles plus 100 warm-up miles have been clocked with gears still OK.

When you write specifications for your product, before investing in expensive tests . . . call in Monsanto. Monsanto can formulate your base stock—ready for field testing—with dozens of possible additives that will do just about any job an additive can do. Corrosion inhibitors • Detergents • Viscosity index improvers • Gear lubricant fortifiers Fuel oil clarifiers • "Oiliness" improvers.

For more information, write to:

Monsanto Chemical Company

Organic Chemicals Division

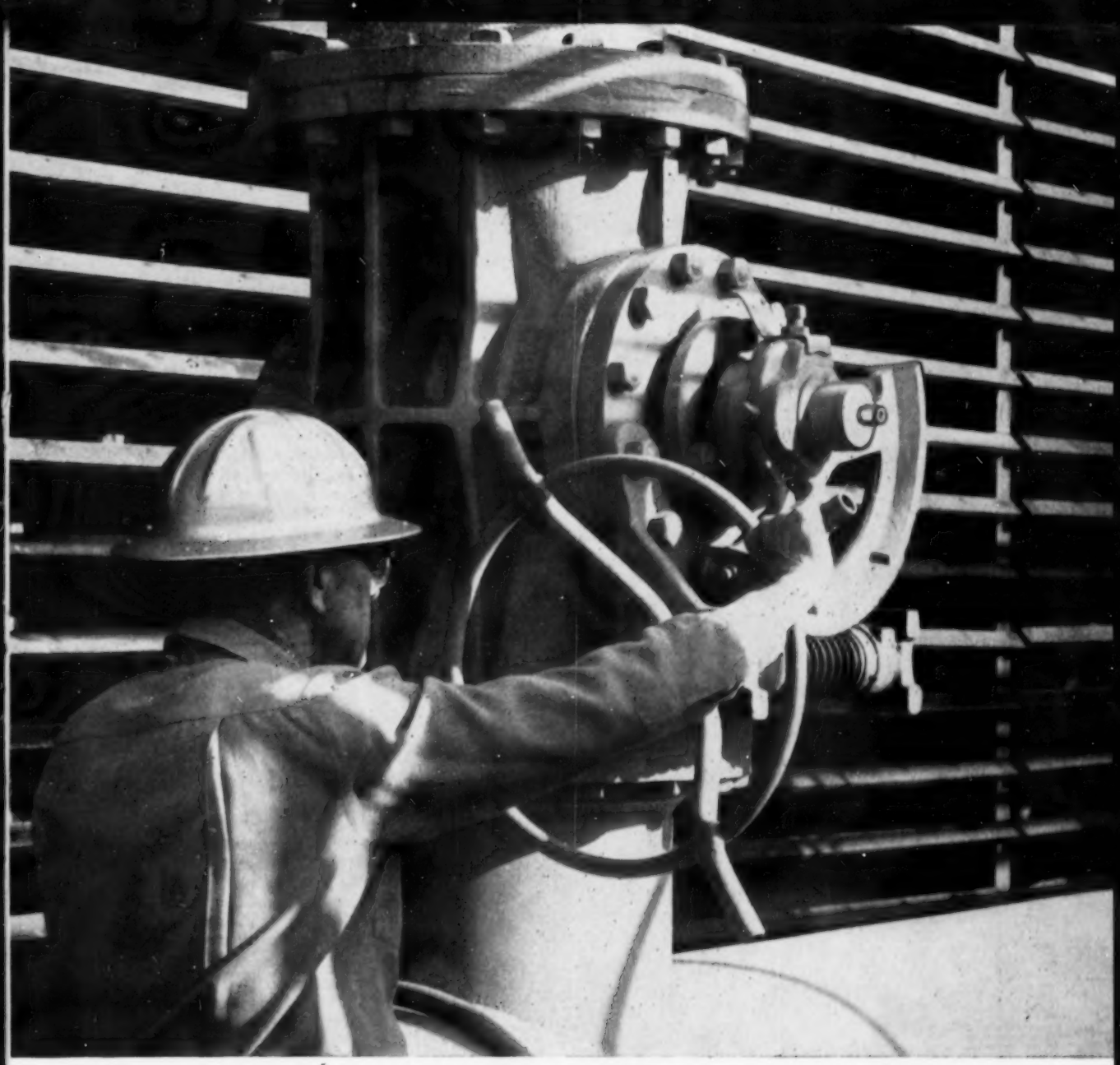
Department OA-2

St. Louis 1, Missouri

MONSANTO

SANTOPOID REG. U.S. PAT. OFF

(To obtain more data on advertised products see page 142)



Reduce Down-Time Costs

with ROCKWELL-Nordstrom VALVES

The two most common valve problems that cause excessive down-time costs are seat failure (leakage) and wear. Performance records in thousands of refineries and gasoline plants prove that Rockwell-Nordstrom valves cut down-time costs because they *stay leakproof* and *wear longer in service* than any other valve. In Rockwell-Nordstrom valves, there are no exposed seats to be cut-out or corroded. Leakproof, positive shut-off is assured by pressurized lubricant sealing. Lubricant also eliminates the metal-to-metal friction that causes ordinary valves to wear out so quickly.

The low maintenance cost and dependability of Rockwell-Nordstrom valves is a matter of record, yet they cost no more to buy, often less, than ordinary valves. Available in a complete range of sizes and pressure ratings. Write today for more information: Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Canadian Valve Licensee: Peacock Brothers Ltd.

ROCKWELL-Nordstrom **VALVES**

Lubricant Sealed for Positive Shut-Off
40th YEAR *of lubricated plug valve leadership*

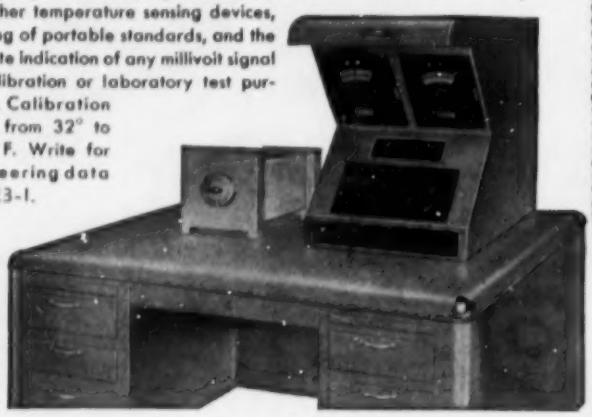
NEW TEST EQUIPMENT FROM THERMO ELECTRIC

MINIMITE Portable Indicator

A midget-size portable potentiometer indicator—this compact, lightweight unit weighs under four lbs. and measures only 4" x 5" x 6". Yet it has a double scale 23½ inches long! Standard range includes a scale of 0°–1800° F. for Iron-Constantan and one of 0°–2400° F. for Chromel-Alumel. Other scales also available. Another outstanding feature—the "Mini Mite" serves a dual purpose! It can be used to measure temperature directly when connected to a thermocouple, or, to check other potentiometer or millivoltmeter type instruments when used as a comparison instrument. A three-position switch permits quick selection of scale or elimination of cold-junction compensation. Write for Bulletin 64-1.

Thermocouple Calibration Console

This complete equipment package was designed for industries requiring frequent calibrations to maintain temperature measuring accuracy. Highly flexible in performance, it provides precision calibration of thermocouples and other temperature sensing devices, checking of portable standards, and the accurate indication of any millivolt signal for calibration or laboratory test purposes. Calibration range from 32° to 2000° F. Write for engineering data EDS-23-1.



Other NEW T-E Instruments

"AutoRef" Cold-Junction Unit • Portable Self-Balancing Indicator
Multi-Point Controller • Standardized Ten-Point Midgit Monitor
Self-Balancing Indicator with Remote Selector and Digital Readout

Pyrometers • Temperature Monitoring Systems • Thermocouples • Protection Tubes
Quick-Coupling Connectors and Panels • Thermocouple and Extension Wires

Thermo Electric Co. Inc.
SADDLE BROOK, NEW JERSEY
In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ontario

company publications on specific equipment pieces and a list of national and international offices. Link-Belt Co., Prudential Plaza, Chicago 1, Ill.

Circle No. **32** *on Reply Card*

Aluminum Fittings

. . . their uses, specifications and applications: *Bulletin TT790-15-756* is a 42-page reference handbook for the design of aluminum piping systems. Included are dimension tables on all fittings, physical properties, fitting tolerances, pressure-temperature ratings, allowable working pressures and corrosion resistance data. Tube Turns, Louisville 1, Ky.

Circle No. **33** *on Reply Card*

Fire Extinguishers

. . . their new ratings by the Underwriters' Laboratories and an outline of a new industrial fire code: these topics are presented in *Kidde Industry, Underwriters' Lab Issue.* Also presented is a description of how equipment is tested when received at Underwriters' new Northbrook, Illinois testing plant. Walter Kidde & Co., Inc., Belleville, N.J.

Circle No. **34** *on Reply Card*

Power Transmission

. . . is described in detail in this 328-page engineering catalog covering Dodge's complete line of mechanical units. The manual contains sectional drawings, dimensions, weights, process application details and engineering tables. A comprehensive 8 page index makes the book easy to use for quick reference. Dodge Manufacturing Corp., Mishawaka, Ind.

Circle No. **35** *on Reply Card*

Aluminum Handbook

. . . is a comprehensive reference book on the use and specification of this material. *Alcoa Aluminum Handbook* presents concise data on aluminum alloys and mill products in an easy to read tabular form. The 176-page, hard covered handbook presents information on alloy standards as well as the properties, sizes, and tolerances of mill products usually produced from them. Aluminum Company of America, 781 Alcoa Building, Pittsburgh 19, Penna.

Circle No. **36** *on Reply Card*

Assembly Kits

. . . for electro-mechanical control systems or computers. Brochure *TDS-1110* gives complete information on

MILLIONS OF BARRELS OF WATER

THROTTLED THROUGH TOUGH HANCOCK VALVES

IN WATER FLOODING OPERATIONS

Water flooding systems demand rugged valves — and a lot of them — to assure reliable control of input flow. For years Hancock Valves have been helping to boost oil recovery economically with efficient throttling service in pump houses, on main headers and on injection lines.

Typical examples of the application of Hancock Valves in water-injection operations are pictured here. At Well No. 1, Mid-Continent Flood of the Sunray Oil Corporation, 616,874 bbls. of salt water were throttled through a single 1" valve in only 3¼ years at an average pressure of 850 lbs. It is one of many Hancocks in the system. Buffalo Oil Co., Wewoka, Okla. has been using Hancock Valves at Olympic Pool for seven years. So has Winona Oil Company of Delaware at Flat Rock Flood, northwest of Tulsa. Earlougher Engineering designed and supervised the installation of the Buffalo and Winona systems.

Whatever the pressure requirements or type of water, there is a tough Hancock Steel or Bronze Valve for the job. The "Flocontrol" types have 3-in-1 design that combines variable orifice, shut-off and index. All types and sizes are functionally engineered and precision built of the finest materials. They withstand wire drawing, galling, erosion and corrosion far longer than ordinary valves — *yet cost no more.* Even under the most adverse conditions of use, you can depend on the tightness of Hancock Valves month after month.

Hancock 600# Steel "Flocontrol" Valves Sizes: ¼" thru 4"

Hancock 600# Steel Valves Sizes: ¼" thru 2"

Hancock 800# Steel Gate Valves Sizes: ¼" thru 2"

When Hancocks go in, valve costs go down.

Hancock Bronze "Flocontrol" Valves Sizes: ¼" thru 2" 150# and 300# series.

Hancock Bronze Valves Sizes: ¼" thru 2" 150#, 200# and 300# series.

Phone your Industrial Supply Distributor for complete information about Hancock Valves for water-injection service. He will gladly help you select the right types and sizes for your particular requirements.

In Canada: **Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario**

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

CUPRIC CHLORIDE

MADE FROM VIRGIN COPPER FROM OUR OWN MINES

PRODUCED BY THE

TENNESSEE CORPORATION

MINERS OF COPPER, ZINC, IRON AND SULPHUR

A SUPERIOR SWEETENING REAGENT IN PETROLEUM REFINING

CUPRIC CHLORIDE DI-HYDRATE

We are in a position to supply your needs on annual, semi-annual or monthly contract basis—also smaller quantities in drop shipment lots.

TYPICAL ANALYSIS

Copper	37.00% minimum
Moisture	12.00% maximum
Fe	.04% maximum
Zn	.01% maximum
Copper Oxychloride—less than	.50% maximum

CHECK THESE FEATURES

High Copper Content
Lower Moisture
Uniform Particle Size
Uniformity
Availability
For
1. Quality Improvement
2. Cost Reduction

Other Tennessee Corporation products:
Ferric Sulfate (Ferri-Floc),
Copper Sulfate
and
Sulfur Dioxide.

For samples make request on your company letterhead.

TENNESSEE CORPORATION

617-629 Grant Building, Atlanta, Ga.

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PETROLEUM PROCESSING—Subscription Department
330 West 42nd Street—New York 36, N. Y.

the kits or separate components which are available for constructing a "breadboard" model of an engineer's original design. Included are detailed descriptions of mounting components, component hangers, clamps, shafts, bearings, gears and the other required pieces. Servo Corporation of America, New Hyde Park, N.Y.

Circle No. **37** *on Reply Card*

Unions & Check Valves

. . . are described in revised issue of *Catalog 56*. Included is information on two new products: lug nut unions and spring controlled check valves. The catalog contains all pertinent data such as pipe sizes, prices, engineering data and specifications. Catawissa Valve & Fittings Co., Catawissa, Penn.

Circle No. **38** *on Reply Card*

Bolted Steel Tanks

. . . and their uses are described in *Catalog No. 656*. Using new synthetic gasket materials, the tanks are available in sizes ranging from 100 to 10,000 bbl capacities. Construction details, pictures of tank assembly and a table of API dimensional specifications for bolted steel tanks are all included in the 16-page brochure. Columbian Steel Tank Co., Kansas City 1, Missouri.

Circle No. **39** *on Reply Card*

Jet-Tray Dearator

. . . design eliminates tubular vent condensers: *Publication 4651* describes this type dearator that handles a wide range of operating conditions and provides effective scrubbing contact between steam and water. Two heaters are used in series: the preheater at the top of the shell meets the incoming water; the second section is fitted with downflow trays to provide spillage and surface contact. Elimination of the tubular vent condensers does not prevent effective purging of non-condensible gases from boiler feedwater. Cochrane Corp., 17th St. below Allegheny Ave., Philadelphia 32, Pa.

Circle No. **40** *on Reply Card*

Bolt Preloading

. . . by using an indicating washer is described in 12-page catalog. *Form 2165*. The device, called PLI-Washer, consists of two concentric steel rings sandwiched between two close tolerance washers. The inner ring is thicker than the outer ring and is compressed as the bolt is tightened. When the inner ring is compressed to the point where

RIDGID

⅛" to 2" Drop-Head Threaders

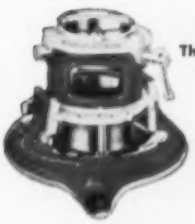
Handiest darned ratchet threaders you ever used!

Really handy, time savers, easy to use. Pick up the size head you need, snap it into the ratchet ring . . . and start threading! Heads can't fall out. Dies reverse easily for close-to-wall threading. Conduit and special dies available. Free carrier with sets. For perfect threads easily and long service, buy 'em at your Supply House.

Carrier Free with Sets

Bolt Threaders, too— ask for RIDGID OOR-B, same easy-work advantages as drop-head pipe dies.

Whole Line of RIDGID Pipe Threaders Offers You Extra-Easy Threading



RIDGID Jam-proof 65R Threads 1" to 2" pipe with 1 set of dies.

RIDGID 504 Threader for power drive use— threads 1" to 2" with 1 set of dies.

RIDGID 4P Geared Threader 2½" to 4" pipe— extra-easy handling, no upkeep.

RIDGIL Top Quality Sulphur-Lard Thread-Cutting Oil

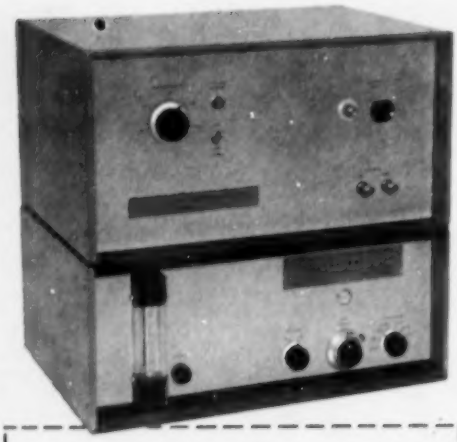
RIDGID

Work-Saver Pipe Tools

The Ridge Tool Company • Elyria, Ohio, U. S. A.

Exclusive heated sampling valve

gives superior reproducibility by eliminating both operator error and sample contamination



CEC's *Type 26-201*

CHROMATOGRAPH

Precise sample volumes are reproducible to better than ± 0.5% with CEC'S revolutionary new *Heated* Sampling Valve. CEC's valve simplifies operation, enhances resolution by minimizing sample diffusion, meters samples directly from a gas stream—thus eliminating possible contamination or dilution with air.

Used independently or as a supplement to mass spectrometers and infrared instruments, CEC's vapor phase Chromatograph provides fast, accurate analysis of almost any mixture, including liquids with boiling points as high as 325°C!

Potential applications of the versatile 26-201 are practically unlimited. Yet cost is low. Operation is simple. Write for complete description and specifications. Bulletin CEC 1831-X5.

COMPARE THESE FEATURES

MODULAR DESIGN...expandable as analytical needs change; columns easily interchanged; quick changeover between stacked analyzer units and central control unit.

WIDE TEMPERATURE RANGE WITH VARIABLE TEMPERATURE CONTROL . . . oven and sampling-valve temperature continuously adjustable from 60°C to 250°C with regulation within ± 0.5°C over entire range.

VERSATILE . . . operates with either adsorption, gas-liquid partition or reaction columns to handle wide variety of compounds... microsamples make instrument practical for all types of laboratories.

Consolidated Electrodynamics

CEC

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

the outer ring binds against the adjacent washer, the desired preload has been induced in the bolt.

Accuracy of the PLI-Washer is ±10%, and permits safe preloading of bolted connections to a high 80% of bolt yield strength. Available from stock are washers for bolts from #10 through 1½-in. in diameter, designed for preloading bolts of tensile strength from 80,000 to 180,000 psi. Available also are washers for stress levels of 125,000 and 160,000 psi. Standard Pressed Steel Co., Jenkintown, Pa.

Circle No. **41** *on Reply Card*

Pump Bulletin

. . . describes a new line of chemical process pumps which have complete interchangeability of components. *Bulletin No. B-1608* lists the specifications for the back plates, impellers, and volute cases which can be combined to obtain desired service characteristics. The Type DL and Type DM pumps are offered to meet the following conditions: up to 800 gpm capacity heads to 400 ft; temperatures to 400°F, and either water cooled packing or water cooled lubrication. Peerless Pump Div., Food Machinery and Chemical Corp., 301 West Avenue 26, Los Angeles 31, Calif.

Circle No. **42** *on Reply Card*

Expansion Joints

. . . of many types are described in detail in a 72-page publication *Catalog 56*. Introduced in the catalog are details on new staff equalizing, duo equalizing, and high pressure toroidal expansion joints. Essential data on 9 other types are also included. Tables and charts present complete engineering specifications, and a selection chart tells how to choose the correct expansion joint for a given set of conditions. Zallea Brothers, Taylor and Locust Streets, Wilmington 99, Del.

Circle No. **43** *on Reply Card*

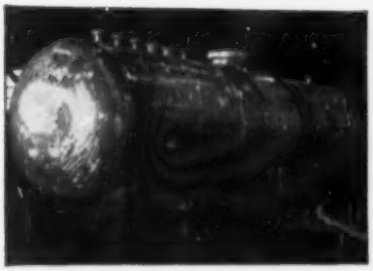
Did You Miss These?

The following items, reviewed originally in June, have aroused considerable interest among readers. They are repeated briefly here as a service to those who might have missed them the first time they appeared. For details or literature please use the regular Reply Card in this issue.

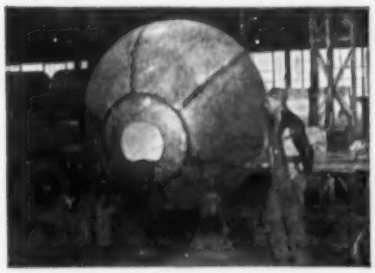
Gasoline Dyeing

. . . is faster and cleaner with the "Dyzooka," a dry eduction probe. In-

Your answer to corrosion problems



Aluminum tank for rocket fuel

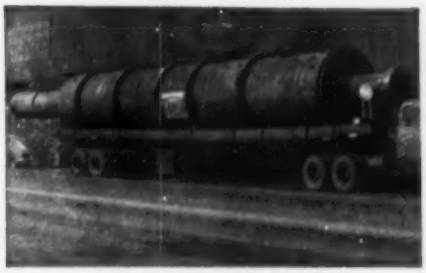


Solid stainless sphere for gas

Do you make or use or store liquids that cannot be contained by carbon steel vessels? If so, Graver will build your tanks and process equipment of corrosion-resisting alloys —stainless, or stainless-clad or aluminum.

Graver's highly developed techniques in alloy welding make it possible to build storage and process vessels to exacting new specifications of corrosion resistance.

Bring your tough problems to Graver.



Stainless-clad vacuum column

GRAVER

- Autoclaves
- Digesters
- Elevated water tanks
- Oil field equipment
- Pressure vessels ✓
- Storage tanks
- Towers
- Weldments

GRAVER TANK & MFG. CO., INC.

East Chicago, Indiana

CHICAGO • NEW YORK • PHILADELPHIA • EDGE MOOR, DEL. • PITTSBURGH • DETROIT • TULSA
SAND SPRINGS, OKLA. • HOUSTON • LOS ANGELES • FONTANA, CAL. • SAN FRANCISCO

(To obtain more data on advertised products see page 142)

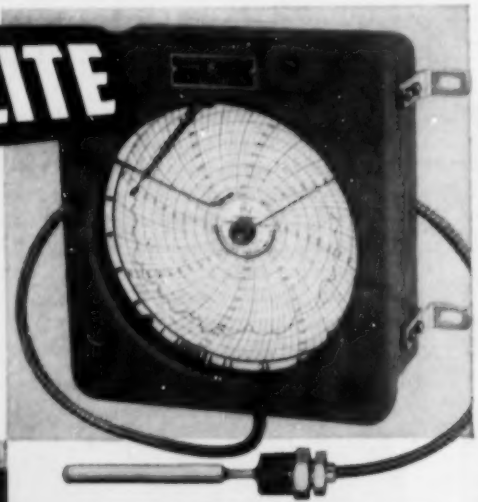
INDUSTRIAL WASTE TREATMENT

Your waste treatment problems can be effectively solved by the skillful recovery of useful products and the re-use of treated water.
Talk it over with our nearest representative . . . he has the COMPLETE LINE of equipment and processes to best serve your needs.

J. W. DROKE & ASSOCIATES

TULSA	FORT WORTH	HOUSTON
R. F. Bogwell	Box 2525	Wm. C. Buchanan
102 East 9th	Carter Field Station	4101 San Jacinto
CHerry 2-8217	CRestview 4-5711	JAckson 8-2072

AUTO-LITE



. . . for TEMPERATURE RECORDING . . .

One of the many uses for Auto-Lite Recorders is the application shown below . . . a natural gas field meter run.

Auto-Lite Model "1000" Temperature Recorder has 6" chart. Various standard ranges from minus 40° F to plus 550° F. Available for wall mounting, portable or portable self contained use. Electric or mechanical chart drive. Choice of 24-hr. or 7-day cycle. Capillary tubing permits remote reading. Priced as low as $49.50. Manufactured to customers' specifications. Send for latest Catalog describing many types of Auto-Lite Recorders and Indicators.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS & INDICATORS

corporated in the probe is an anemometer for measuring airflow, so that when the probe and anemometer are joined together the assembly resembles a bazooka . . . hence the name "dyzooka."

One of the main advantages of the new probe is that it is clogproof under a wide range of field conditions. It is now possible to introduce dye directly from a shipping drum into the finished gasoline. Pre-dissolving as an intermediate step is not required.

The probe is an aluminum tube within a tube. The inner one sucks the dye from the container into the gasoline stream; the outer tube supplies a downdraft of air which is controlled by two adjustable ports. The ports assure fluidized flow of the dry dye. E. I. du Pont de Nemours & Co., Public Relations Dept., Wilmington, Del.

Circle No. **44** *on Reply Card*

Plastic Pipe Markers

. . . are easily applied over any existing pipe lines. No preparation such as scraping or cleaning is required. The pre-formed plastic label snaps over either the bare pipe or the insulation, and is held in place by cementing the overlapping edges of the label itself.

The "Pype Identification Marker" has a color coded background, with the identifying words printed under a protective sheet of vinylite. Printing is arranged so that the label can be read from any direction. Because the vinylite cover is resistant to most chemicals it will remain bright and clear throughout its service life.

The markers come in sheets up to 25 x 21 in. and are pre-formed to clamp around pipes ranging in diameter from ½ to 30-in. They are also available with holes cut out for installing around valves. Wilmington Plastics Co., 810 S. Heald St., Wilmington 1, Del.

Circle No. **45** *on Reply Card*

Refractometer

. . . continuously monitors process plant streams. Any variations in the stream can be detected quickly, and necessary changes made to bring the product back to standard.

Available in models with limiting sensitivity ranges of 0.0001, 0.00001, or 0.000002, this instrument measures the difference in refractive index between a flowing liquid sample and a reference sample. A sealed optical system, photocell detection, temperature compensating, and null balance system transmits a change in refractive index

why engineers go for Gun-Pakt Expansion Joints

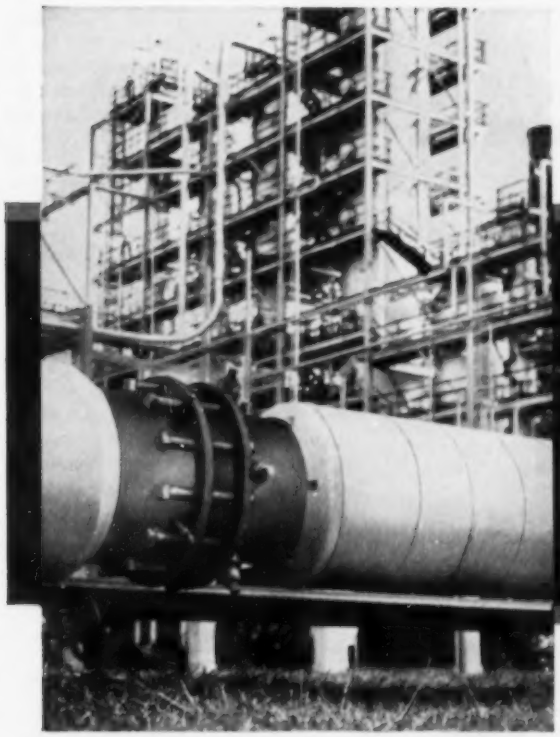
■ Engineers go for Yarway Gun-Pakt Expansion Joints because:

NO SHUTDOWNS. With Gun-Pakt Joints when new packing is needed, it is added under full steam pressure, right on the job—no unpacking, no shutdowns, no service interruptions.

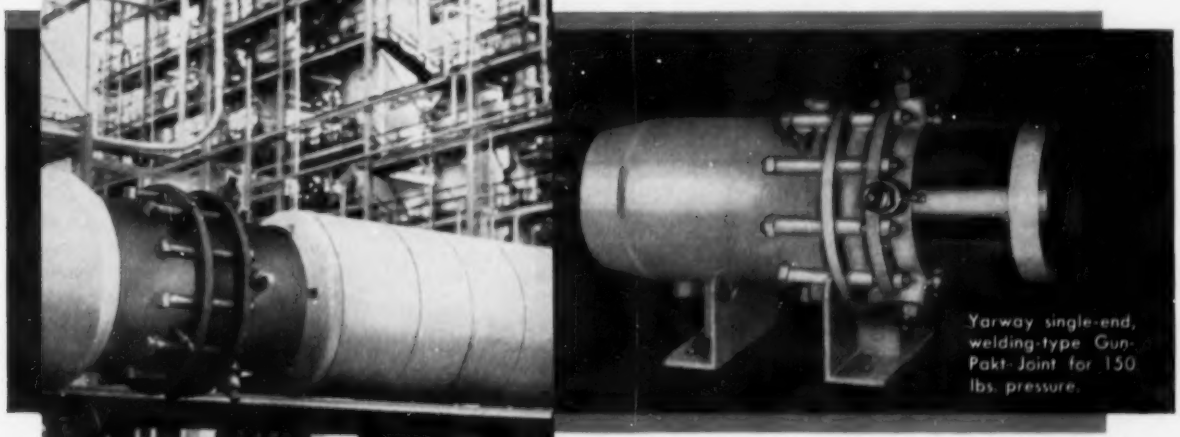
FEWER JOINTS NEEDED. With Gun-Pakt Joints you need fewer joints per length of pipe line, with traverses up to 12" single and 24" double.

LONG SERVICE—NO METAL FATIGUE. Gun-Pakt Joints give long, trouble-free service life—no fatigue failures.

LOW MAINTENANCE. Maintenance records show the costs for servicing Gun-Pakt Joints are very low. One utility reports only 65 cents per year per joint—another reports less than half that.



One of 37 Yarway Gun-Pakt Expansion Joints installed at giant oil refinery on Gulf Coast. Gun-Pakt Joints at this refinery range in size from 1½" to 14".



Yarway single-end, welding-type Gun-Pakt Joint for 150 lbs. pressure.

Leading institutions, central heating stations and industrial plants "go for Gun-Pakt" again and again. Write now for latest bulletin EJ-1914.

YARNALL-WARING COMPANY
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YARWAY GUN-PAKT EXPANSION JOINTS

J-M BLAZECRETE speeds refractory repairs...

That's why it pays you to use this hydraulic setting refractory for temperatures to 3000F

REPAIR old refractory linings—or build new ones—quickly and economically with Blazecrete*. For troweling, just mix Blazecrete with water as you'd mix ordinary concrete . . . then slap-trowel it in place.

When gunned, it adheres readily with a minimum of rebound loss. Either way, Blazecrete goes on fast . . . without laborious ramming or tamping. *And Blazecrete linings last.*

Three types of hydraulic-setting Blazecrete are available. All harden on air curing, do not require prefiring. They are furnished as a dry mix . . . can be stored safely for use as needed.

3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

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Send for Brochure RC-28A on Blazecrete and its companion material, Firecrete*. . . the hydraulic setting castable refractory for making special shapes and linings. Write Johns-Manville, Box 14, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

*Reg. U.S. Pat. Off.

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Johns-Manville **BLAZECRETE**

BUILDS BETTER REFRACTORY LININGS

to a visual dial or a remote recorder. Accuracy is claimed better than ±½%. Barnes Engineering Co., 30 Commerce Road, Stamford, Conn.

Circle No. **46** *on Reply Card*

High Pressure Equipment

. . . for process conditions up to 7,500 psi and 1,000°F: a 53-page catalog, *Hofer High Pressure Apparatus*, describes the wide range of special equipment available from the German firm which designed some of the equipment for the original Fischer-Tropsch synthesis. Included are details of compressors, autoclaves and catalytic apparatus for critical operating conditions. Chemtech Products Corp., 276 Forest Ave., Glen Ridge, N. J.

Circle No. **47** *on Reply Card*

Electronic Instruments

. . . for recording and controlling: *Bulletin P1245-A*, catalogues in 63 pages the many applications of the continuous-balance potentiometer for the control or telemetering of process conditions. Included is information on the many different sensing elements which can be used with these electronic instruments. Bristol Co., Waterbury 20, Conn.

Circle No. **48** *on Reply Card*

Waste Treatment

. . . problems and how to solve them: *Technical Paper No. 64* presents several practical systems for process and waste water treatment using controlled-volume pumps to meter the chemicals and additives. Discussed in detail are the processes of coagulation, clarification, boiler water treatment, and oxygen scavenging by addition of hydrazine. Milton Roy Co., Station L, 1300 E. Mermaid Lane, Philadelphia 18, Penn.

Circle No. **49** *on Reply Card*

Alloy Tubes

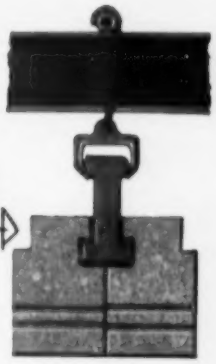
. . . for heat exchangers and condensers: 44-page manual, *Publication B-2*, is designed to assist engineers in the selection of tubes and plates. The booklet discusses their applications, methods of manufacturing, plus hints on their installation. A special section deals with corrosion factors in condenser tube service, and another lists physical properties and tabular data concerning heat exchanger and condenser tubes. American Brass Co., 25 Broadway St., New York 4, N.Y.

Circle No. **50** *on Reply Card*

This tile is called a dog bone!

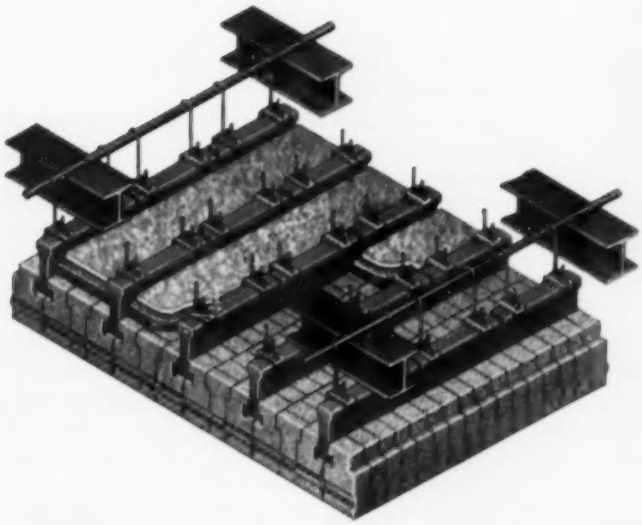
It's a husky supporting tile—used instead of an expensive alloy casting in a double suspended arch designed by B-L for high temperature aluminum, steel and glass furnaces. It can stand extremely high temperatures—can be used with or without insulation.

The dog bone supports two beam tile.



Bottom lugs are sloped so that the weight of the beam tile will draw the two together—like this:

Filler tile space out the arch so that the completed job looks this way:



Naturally the completed arch will possess all of the inherent characteristics of Bigelow-Liptak suspended construction. Burned out or damaged tile can be removed without disturbing large areas. Expansion is confined to individual tile—will not accumulate over the entire width of the arch. It all adds up to more production—less down time through keeping heat from raising the roof.

We'd like to tell you more about it. Just write.

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AND BIGELOW-LIPTAK EXPORT CORPORATION

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EDITORIALS . . .

Careful, Bud, That Wind's Shifty

THE petroleum processor who sneers at his brothers out in Los Angeles and says air pollution is no concern of his because "we don't have inversion layers in our part of the country" or "our fumes always blow away from the city" could be in for a rude awakening one of these days.

Take a look at what's happening over in Ashtabula, a northeast Ohio city on the southern shore of Lake Erie. Ashtabula has quite a bit of chemical industry (no refineries), and smoke and fumes from these plants are usually blown out over Lake Erie by the prevailing wind. There they are harmlessly dispersed.

But in recent months these winds haven't been quite so obliging. For days at a stretch instead, they've been moving obnoxious fumes from some of the plants to Ashtabula's residential areas. Some of the results: smarting eyes, raw throats, dying plants—and a lot of noise from the residents.

One complicating little aspect is that many of the industrial units are outside city limits, and, therefore, Ashtabula has its hands pretty well tied. It has requested help from the County commissioners, and from state and federal officials.

We don't profess to know what will happen in Ashtabula. Maybe the companies will have to control their emissions of smoke and fumes—or perhaps the winds will return to normal, and the present stink will blow away. But there's a moral in this tale.

Don't count entirely on nature to solve all your pollution problems. She can be a shifty creature.

Don't Sell "Foreigners" Short

BACK about 20-odd years ago—in the days before World War II—we used to hear talk along these lines: "Don't expect too much in the way of scientific advances from the Japanese. They're marvelous imitators. They can take American engineering discoveries and developments, and they can duplicate them to nth degree. But they just aren't original thinkers in their own right at all."

That kind of talk and thinking in this country soon died out with the start of World War II. Actually, there were probably not many scientists or engineers in the U.S. who put stock in it at any time. Yet it did exist and persist for some time.

(By the way, there's some further up-to-date evidence in this issue to throw out that opinion. See pp. 15-16 and 55-57 for two reports on recent petroleum processing developments in both Japan and China.)

The important point, however, and the lesson we should have learned, is to keep from having the same ideas about any other countries today. A vast amount of the earth is now behind Russia's Iron Curtain. Information on scientific and technological achievements in these areas is extremely meager. True, there are occasional reports on nuclear bomb demonstrations, but beyond these, Americans hear little of industrial progress.

Again, we will admit that informed and thinking technical men probably are convinced that the Russians are not standing still. Quite to the contrary, they should be making great strides in industrial know-how. It could not be otherwise in light of the reports we have on the emphasis Russia is placing on the training of engineers.

In spite of this, we do hear from less informed people in U.S. business and industry some of the same old clichés that once were applied to the Japanese.

Let's squelch this attitude. It's dangerous.

Let's increase wherever possible the emphasis on our own training of engineers and scientists. It is inherent with man to strive for technical progress, regardless of his political philosophy or the government he supports.

Coal Could Learn a Lot from Oil

THE coal industry—or at least a small allied segment of it—is finally awakening to the advantages that are available to it in the technical progress made by the petroleum processing industry.

Jones & Laughlin Steel Co. has announced plans to use Esso's Hydrofining and UOP's Udex processes for improving the quality of the aromatics it now recovers as a by-product from the coking of coal. The company will install the two units at its Aliquippa, Penna. works at a cost of about $2-million.

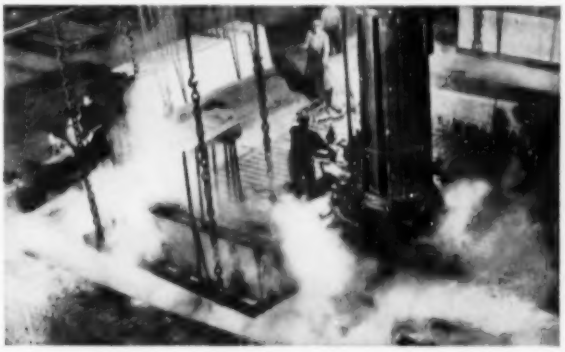
Normally, the aromatics in coke-oven oil are extracted and purified by sulfuric acid washing. This method used to be satisfactory—until petroleum aromatics of high purity became widely available, and began to set the standard for specifications. Coal aromatics producers so far haven't been able to obtain as high a degree of purity as refiners without substantial loss of aromatics product. In addition, acid treating forms sludges that sometimes present troublesome disposal problems.

Now, Jones & Laughlin plans to feed its coke-oven oil to a 1300 b/d Hydrofiner for treatment with hydrogen to remove sulfur compounds. The desulfurized oil will be handled in a 1340 b/d Udex unit for solvent extraction of selected aromatics.

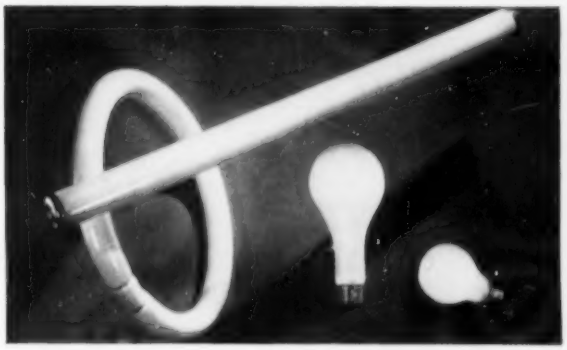
We're sure there are other areas where coal could benefit from oil's technology. The only thing that surprises us is that it has taken coal this long to awaken to the advantages oil can offer.

ANHYDROUS Hydrofluoric Acid for alkylation catalyst; also catalyst and fluorinating agent in many other organic and inorganic reactions.

AQUEOUS Hydrofluoric Acid for steel pickling, glass frosting and etching; also for electropolishing of metals, ore flotation, manufacture of other chemicals.



For "HF" Call GENERAL



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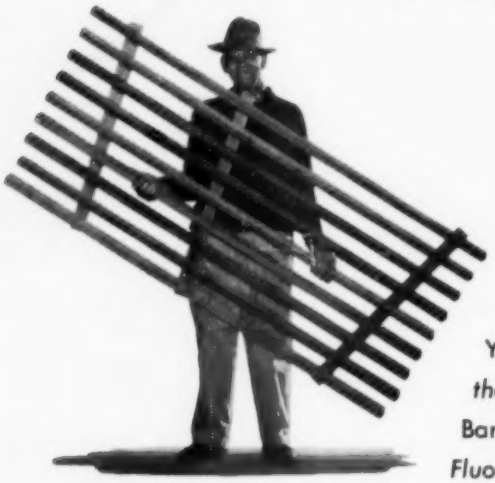
RE-EXAMINE YOUR COOLING TOWER'S FILLING

It Determines The Life of Your Tower!



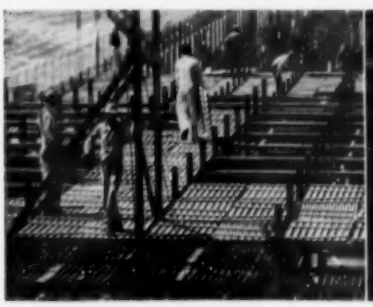
A cooling tower's filling is in reality its heart. The design, construction and *ruggedness* of that filling largely determines the life of the tower.

All of the members used in standard Fluor filling have a minimum thickness of one inch. *The life of this fill is several times that of the usual lath type construction!*

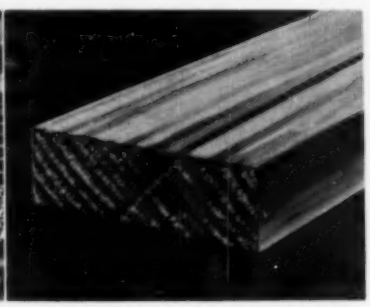
You get more years of dependable performance *at the lowest possible maintenance* with Fluor Sloping Bar Grid Decks — *a standard design feature on all Fluor Industrial Cooling Towers!*

Fluor uses only 100% clear all heart redwood for filling

Fluor grid decks are not only sturdily built but are made from the highest grade redwood lumber—100% clear all heart redwood—the finest cut of the log. Clear all heart redwood is free from defects and sapwood and under normal controlled water conditions will give many many years of trouble-free service. We invite you to investigate our filling before making your selection of a cooling tower.



Grid decks serve as scaffolding during erection



A 1 x 3 makes two bars for Fluor grid decks

Grid decks easily support three 200 lb. men

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